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THE FUEL OF FIFTY CITIES

Ernst and Ernst
Washington, D.C.

November 1968

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THE FUEL OF FIFTY CITIES

Report Prepared For
Department of Health, Education, and Welfare
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration

November, 1968

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ERNST & ERNST
1225 CONNECTICUT AVE., N. W.
WASHINGTON, D. C. 20036

November 15, 1968

Mr. Donald F. Walters
Deputy Chief
Abatement Program
National Air Pollution Control
Administration
U.S. Public Health Service
Department of Health, Education,
and Welfare
Washington, D. C.

Dear Mr. Walters:

We are pleased to submit our report entitled, "The Fuel of Fifty Cities." This submission fulfills the requirements of Contract No. PH 86-68-37 Article I.D.(2). The report contains the results of a survey of fossil fuel prices to stationary combustion sources in fifty cities. It also presents a methodology for comparing the costs of the several fuels in relation to pollutant emissions. The methodology permits the costs of air pollution abatement by fuel change to be estimated rapidly for the fifty cities of the survey.

Very truly yours,

Ernst & Ernst

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CHAPTER I - INTRODUCTION AND SUMMARY

INTRODUCTION

The combustion of fossil fuels is the major source of sulfur dioxide and particulate air pollution in urban areas. One means of reducing this pollution is to replace the fuel presently used by a fuel of lower sulfur and lower ash content. There are generally three alternative fuels -- coal, oil, and natural gas. Since the costs and the pollutant emission rates of these fuels can differ considerably, depending on the area of the United States, fuel changes must be carefully analyzed.

Under contract to the National Air Pollution Control Administration, Ernst & Ernst has conducted a survey of coal, oil, and gas prices and sulfur content in fifty metropolitan areas of the United States. The results of that survey are presented in this report. A methodology is also presented for applying these costs in a specific situation to arrive at the most feasible change to a less polluting fuel.

The fuel survey was taken from March to June 1968. The results of the survey are estimates of the current prices of various grades of fuels correlated with sulfur and ash content. Prices of fuels vary with the quantity purchased. Four classes of users are defined in terms of the quantities of each type of fuel consumed: domestic, commercial, and industrial users and power plants.

The survey covered fifty metropolitan areas, which are listed in Exhibit I-1. In subsequent exhibits metropolitan areas comprised of more than one city are indicated by the major city of the area. The sources of the price estimates are dealers' prices from a telephone survey in the fifty cities and published sources, cited in the appropriate chapters and in a list at the end of this report. None of the

prices were independently verified by Ernst & Ernst.

The remainder of this chapter summarizes the results of the survey. Chapters II through IV present the detailed results for each fuel type. Chapter V is a special chapter on the price of fuels to power plants and is based on 1966 data from published sources only. Chapter VI describes and demonstrates the method mentioned for determining the most feasible alternative fuel in a particular situation.

SUMMARY OF FUEL COSTS

Exhibits I-2 through I-5 show the mean prices of fuels to the several classes of users. Prices are shown in dollars per million British Thermal Unit (BTU). The mean prices were calculated from the data presented in Chapters II through V. Descriptions of the fuels and classes of users, the assumptions made, and the limitations on the prices presented appear in those chapters. No allowance was made for heat loss of coal or fuel oil during combustion because of different fuel efficiencies. To adjust the prices presented for efficiency, divide by the efficiency expressed as a decimal.

In Exhibits I-3 and I-4 two classifications have been used for the sulfur content of coal and of fuel oil grade no.'s 5 and 6. The fuel oils have been grouped as either "maximum one percent sulfur" or "no sulfur maximum" guaranteed. "No sulfur maximum" means that the fuel oil could have any amount of sulfur over one percent. Similarly, coal prices have been grouped by high and low sulfur content according to coal producing district. The price to a coal user in a particular city is the price of coal from the nearest low or high sulfur district. The districts are identified in Chapter II.

In some cases there are no entries in the exhibits for a fuel in a particular city. Where coal or fuel oil prices do not appear,

it is because little or no information could be obtained, presumably since coal or fuel oil is not used or is used in small quantities in that city. The prices for natural gas were obtained from published sources only; prices are not published and therefore do not appear in the exhibits for cities where gas service is not presently available or is available only on an individually negotiated contract basis. A non-entry for fuel used by power plants indicates that in 1966, the year of available published data, no power plants in the city in question used that fuel.

EXHIBIT I-1

METROPOLITAN AREAS INCLUDED IN FUEL SURVEY
(GROUPED BY MARKETING AREA)

NEW ENGLAND

Hartford, Connecticut
Boston, Massachusetts
Providence-Pawtucket-Warwick, Rhode Island-Massachusetts

MIDDLE ATLANTIC

Buffalo, New York
New York, New York
Syracuse, New York
Allentown-Bethlehem-Easton, Pennsylvania-New Jersey
Philadelphia, Pennsylvania
Pittsburgh, Pennsylvania

SOUTH ATLANTIC

Wilmington, Delaware-New Jersey-Maryland
Washington, D. C.-Maryland-Virginia
Jacksonville, Florida
Miami, Florida
Atlanta, Georgia
Baltimore, Maryland
Norfolk-Portsmouth, Virginia
Charleston, West Virginia
Huntington-Ashland, West Virginia-Kentucky-Ohio

EAST NORTH CENTRAL

Chicago, Illinois
Gary-Hammond-East Chicago, Indiana
Indianapolis, Indiana
Detroit, Michigan
Flint, Michigan
Akron, Ohio
Cincinnati, Ohio-Kentucky-Indiana
Cleveland, Ohio
Steubenville-Wierton, Ohio-West Virginia
Toledo, Ohio-Michigan
Milwaukee, Wisconsin

EAST SOUTH CENTRAL

Birmingham, Alabama
Louisville, Kentucky-Indiana
Chattanooga, Tennessee-Georgia
Memphis, Tennessee-Arkansas

Exhibit I-1, cont'd

Metropolitan Areas Included in Fuel Survey
(Grouped by Marketing Area)

WEST NORTH CENTRAL

Davenport-Rock Island-Moline, Iowa-Illinois
Kansas City, Missouri-Kansas
Minneapolis-St. Paul, Minnesota
St. Louis, Missouri-Illinois
Omaha, Nebraska-Iowa

WEST SOUTH CENTRAL

New Orleans, Louisiana
Oklahoma City, Oklahoma
El Paso, Texas
Houston, Texas

MOUNTAIN

Phoenix, Arizona
Denver, Colorado
Salt Lake City, Utah

PACIFIC

Los Angeles-Long Beach, California
San Francisco-Oakland, California
Portland, Oregon-Washington
Seattle-Everett, Washington

HAWAII

Honolulu, Hawaii

EXHIBIT I-2

MEAN SURVEYED PRICES[1] PER MILLION BTU
TO DOMESTIC USERS[2] FOR COAL, FUEL OIL,
AND NATURAL GAS IN FIFTY METROPOLITAN AREAS

District/ Metropolitan Area	Coal [3]		Fuel Oil [3]		Natural Gas [3]
	Low Sulfur	High Sulfur	No. 1	No. 2	
NEW ENGLAND					
Hartford	$	$	$	$	$1.56
Boston	1.14			1.20	1.87
Providence					1.93
MIDDLE ATLANTIC					
Buffalo				1.29	1.75
New York				1.29	1.60
Syracuse					1.15
Allentown			1.40	1.26	1.55
Philadelphia			1.31	1.25	1.48
Pittsburgh					0.91
SOUTH ATLANTIC					
Wilmington	0.92				1.44
Washington	1.14	0.78	1.49	1.25	1.30
Jacksonville	0.97		1.34	1.22	2.28
Miami			1.35	1.23	3.12
Atlanta		0.49			0.90
Baltimore	0.87			1.25	1.36
Norfolk			1.15	1.00	1.62
Charleston					0.83
Huntington					0.88
EAST NORTH CENTRAL					
Chicago			1.32	1.20	1.06
Gary					0.99
Indianapolis					0.91
Detroit			1.34	1.22	0.87
Flint	0.84		1.30	1.18	1.21
Akron	0.73	0.57			
Cincinnati				1.18	0.73
Cleveland			1.34	1.22	0.81
Steubenville					0.85
Toledo					
Milwaukee			1.39	1.26	1.17
EAST SOUTH CENTRAL					
Birmingham			1.37	1.25	1.12
Louisville			1.39	1.28	0.71
Chattanooga				1.18	1.31
Memphis				1.16	0.80
WEST NORTH CENTRAL					
Davenport			1.34	1.21	0.75
Kansas City			1.28	1.16	0.59
Minneapolis			1.38	1.26	1.02
St. Louis			1.35	1.22	1.01
Omaha			1.31	1.19	0.72
WEST SOUTH CENTRAL					
New Orleans				0.95	0.68
Oklahoma City				1.10	
El Paso			1.17	1.13	0.73
Houston			1.18	1.13	0.92
MOUNTAIN					
Phoenix			1.55	1.28	1.08
Denver	0.65		1.23	1.10	0.68
Salt Lake City			1.32	1.11	0.63

Exhibit I-2, cont'd

Mean Surveyed Prices[1] Per Million BTU
To Domestic Users[2] For Coal, Fuel Oil,
And Natural Gas In Fifty Metropolitan Areas

District/ Metropolitan Area	Coal [3]		Fuel Oil [3]		Natural Gas [3]
	Low Sulfur	High Sulfur	No. 1	No. 2	
PACIFIC					
Los Angeles	$	$	$1.33	$1.17	$0.93
San Francisco			1.36	1.20	0.77
Portland				1.19	1.52
Seattle			1.40	1.24	1.30
HAWAII					
Honolulu				1.26	

1/ Coal prices are 1968 prices obtained by telephone survey of coal dealers. Fuel oil prices are estimates of 1968 prices based on information from fuel oil dealers and published sources (see Chapter III). Gas prices are published 1966 prices (see Chapter IV).

2/ A domestic user purchases one- to four-ton lots of coal, 100 to 200 gallons of fuel oil, and natural gas for a single family residence.

3/ No entry implies inadequate information obtained, possibly because the fuel is not used in the city or is used in small quantities.

EXHIBIT I-3

MEAN SURVEYED PRICES[1] PER MILLION BTU
TO COMMERCIAL USERS[2] FOR FUEL OIL AND NATURAL
GAS[3] IN FIFTY METROPOLITAN AREAS

District/ Metropolitan Area	Fuel Oil [4]							Natural Gas [4]	
				No. 5		No. 6			
	No. 1	No. 2	No. 4	Maximum 1% Sulfur	No Sulfur Maximum	Maximum 1% Sulfur	No Sulfur Maximum	Firm	Interruptible
NEW ENGLAND									
Hartford	$	$	$	$	$	$	$0.56	$1.55	$0.68
Boston	1.23	1.09	0.75		0.67		0.48	1.75	
Providence	1.23	1.09	0.71		0.67		0.49	1.79	
MIDDLE ATLANTIC									
Buffalo		1.12		0.77		0.69	0.64	1.20	
New York	1.21	1.07	0.68		0.59	0.57	0.47	1.57	0.65
Syracuse								1.09	
Allentown						0.73	0.58	1.37	0.48
Philadelphia	1.20	1.06	0.75		0.69	0.63	0.48	1.45	
Pittsburgh								0.76	
SOUTH ATLANTIC									
Wilmington								1.25	
Washington	1.21	1.07					0.48	1.30	0.60
Jacksonville	1.19	1.05					0.47	1.29	0.40
Miami	1.33	1.19					0.47	1.82	0.41
Atlanta	1.17	1.03						0.60	
Baltimore	1.20	1.06	0.72		0.65		0.47	1.53	0.54
Norfolk	1.21	1.07	0.69		0.60		0.47	1.11	0.45
Charleston						0.75		0.69	
Huntington						0.66		0.72	
EAST NORTH CENTRAL									
Chicago	1.04	0.93		0.81	0.76	0.68	0.64	0.89	
Gary								0.93	0.53
Indianapolis	1.09	0.98						0.81	
Detroit	1.10	0.99		0.77	0.75	0.71	0.69	0.81	
Flint								0.91	
Akron									
Cincinnati								0.68	
Cleveland	1.31	1.16						0.70	
Steubenville						0.70		0.78	
Toledo	1.31	1.16			0.78		0.72		
Milwaukee	1.14	1.03						1.08	
EAST SOUTH CENTRAL									
Birmingham	1.17	1.03						0.54	0.43
Louisville								0.60	0.52
Chattanooga	1.12	0.98						1.02	0.44
Memphis		0.93			0.52		0.47	0.50	
WEST NORTH CENTRAL									
Davenport								0.66	
Kansas City	1.12	0.98					0.45	0.58	0.44
Minneapolis	1.15	1.03			0.81		0.72	0.85	0.49
St. Louis	1.09	0.96				0.59	0.56	0.83	
Omaha	1.12	1.01						0.60	0.47
WEST SOUTH CENTRAL									
New Orleans	1.13	0.99			0.59		0.47	0.40	
Oklahoma City	1.08	0.94					0.43		
El Paso								0.44	
Houston							0.44	0.49	

Exhibit I-3, cont'd

Mean Surveyed Prices[1] Per Million BTU To Commercial Users[2] For Fuel Oil And Natural Gas[3] In Fifty Metropolitan Areas

District/ Metropolitan Area	Fuel Oil [4]							Natural Gas [4]	
				No. 5		No. 6			
	No. 1	No. 2	No. 4	Maximum 1% Sulfur	No Sulfur Maximum	Maximum 1% Sulfur	No Sulfur Maximum	Firm	Interruptible
MOUNTAIN									
Phoenix	$	$	$	$	$	$	$	$0.62	$
Denver								0.56	
Salt Lake City							0.55	0.59	
PACIFIC									
Los Angeles	0.97	0.86			0.49		0.35	0.60	
San Francisco								0.63	
Portland					0.68		0.58	1.43	
Seattle								1.30	
HAWAII									
Honolulu								3.10	

1/ Fuel oil prices are estimates of 1968 prices based on information from fuel oil dealers and published sources (see Chapter III). Gas prices are published 1966 prices (see Chapter IV).

2/ A commercial user purchases four- to twelve-ton lots of coal, 1,000 to 2,500 gallons of fuel oil, and natural gas for apartment buildings, office buildings, hotels, schools, hospitals, etc.

3/ Inadequate price information obtained on coal for commercial users.

4/ No entry implies inadequate information obtained, possibly because the fuel is not used in the city or is used in small quantities.

EXHIBIT I-4

MEAN SURVEYED PRICES[1] PER MILLION BTU
TO INDUSTRIAL USERS[2] FOR COAL, FUEL OIL,
AND NATURAL GAS IN FIFTY METROPOLITAN AREAS

District/ Metropolitan Area	Coal[3]		Fuel Oil[3]							Natural Gas[3]	
						No. 5		No. 6			
	Low Sulfur	High Sulfur	No. 1	No. 2	No. 4	Maximum 1% Sulfur	No Sulfur Maximum	Maximum 1% Sulfur	No Sulfur Maximum	Firm	Interruptible
NEW ENGLAND											
Hartford	$0.48	$0.40	$	$	$	$	$	$	$0.43	$1.43	$0.54
Boston	0.44		0.95	C.84	0.58		0.52		0.37	1.75	0.36
Providence	0.48		0.95	0.84	0.55		0.52		0.38	1.14	
MIDDLE ATLANTIC											
Buffalo	0.38	0.34		0.87		0.59		0.54	0.50	0.97	
New York	0.45	0.38	0.94	0.83	0.53		0.45	0.44	0.37	1.30	0.44
Syracuse	0.46	0.37								0.02	1.68
Allentown	0.43	0.37						0.56	0.45	0.88	0.48
Philadelphia	0.43	0.37	0.93	0.82	0.58		0.53	0.49	0.37	1.00	0.33
Pittsburgh	0.39	0.36								0.52	
SOUTH ATLANTIC											
Wilmington	0.43	0.37								0.76	0.37
Washington	0.40		0.94	0.83					0.37		0.60
Jacksonville	0.39		0.92	0.81					0.37		0.40
Miami	0.44		1.03	0.92					0.37	1.03	0.41
Atlanta	0.41	0.40	0.90	0.80						0.60	0.30
Baltimore	0.42	0.36	0.93	0.82	0.56		0.50		0.37	0.83	0.50
Norfolk	0.39		0.94	0.83	0.54		0.46		0.37	0.79	0.45
Charleston	0.28							0.58		0.65	0.42
Huntington	0.30							0.51			0.43
EAST NORTH CENTRAL											
Chicago	0.40	0.32	0.81	0.72		0.63	0.59	0.53	0.49	0.56	0.28
Gary	0.40	0.32								0.43	0.29
Indianapolis	0.38	0.36	0.85	0.76						0.60	0.40
Detroit	0.38	0.37	0.85	0.77		0.60	0.58	0.55	0.53	0.55	0.43
Flint	0.40	0.37								0.57	
Akron	0.41										
Cincinnati	0.33	0.37									
Cleveland	0.37	0.30	1.01	0.90						0.54	
Steubenville	0.37							0.54		0.49	
Toledo	0.36	0.32	1.01	0.90			0.61		0.56		
Milwaukee	0.43	0.36	0.88	0.80						0.87	0.49
EAST SOUTH CENTRAL											
Birmingham	0.40	0.40	0.90	0.80						0.35	0.31
Louisville	0.35	0.26								0.45	0.46
Chattanooga	0.38	0.39	0.87	0.76						0.64	0.37
Memphis	0.43	0.35		0.72			0.40		0.37	0.33	0.23
WEST NORTH CENTRAL											
Davenport	0.49	0.35								0.54	0.265
Kansas City	0.50	0.40	0.87	0.76					0.34		0.24
Minneapolis	0.50	0.41	0.89	0.80			0.63		0.56	0.75	0.37
St. Louis	0.40	0.31	0.85	0.74				0.45	0.44	0.55	0.33
Omaha	0.52	0.42	0.87	0.78						0.48	0.28
WEST SOUTH CENTRAL											
New Orleans		0.38	0.88	0.77			0.45		0.37	0.23	
Oklahoma City		0.38	0.84	0.73					0.34		
El Paso										0.44	
Houston									0.34	0.25	
MOUNTAIN											
Phoenix										0.49	
Denver	0.40										0.24
Salt Lake City	0.37								0.42	0.37	0.26
PACIFIC											
Los Angeles	0.54		0.75	0.67			0.38		0.27	0.54	0.32
San Francisco	0.54									0.55	0.38
Portland	0.58						0.53		0.45	0.62	0.36
Seattle	0.50						0.54		0.45	1.00	0.35
HAWAII											
Honolulu									0.44	2.10	

1/ Coal and fuel oil prices and estimates of 1968 prices based on a telephone survey of dealers and on published sources (see Chapters II and III). Gas prices are published 1966 prices (see Chapter IV).

2/ An industrial user purchases coal in rail car lots, 6,000 to 12,000 gallons of fuel oil, and large volumes of natural gas, usually with a restriction on demand (see Chapter IV).

3/ No entry implies inadequate information obtained, possibly because the fuel is not used in the city or is used in small quantities.

EXHIBIT I-5

MEAN 1966 PRICES[1] PER MILLION BTU
TO POWER PLANTS[2] FOR COAL, FUEL OIL,
AND NATURAL GAS IN SURVEYED METROPOLITAN AREAS

District/ Metropolitan Areas	Fuel Oil [3]		Coal [3]	Natural Gas [3]	
	Light Grades	Heavy Grades		Firm	Interruptible
NEW ENGLAND					
Hartford	$	$0.335	$0.324	$	$0.324
Boston		0.315	0.353		0.312
Providence		0.333	0.328		0.363
MIDDLE ATLANTIC					
Buffalo			0.274		
New York	0.717	0.319	0.314		0.360
Syracuse					
Allentown	0.688		0.259		
Philadelphia	0.825	0.313	0.290		
Pittsburgh	0.800		0.182		
SOUTH ATLANTIC					
Wilmington		0.402	0.207		0.135
Washington			0.279		
Jacksonville		0.335			
Miami		0.327			0.340
Atlanta	0.741		0.259		
Baltimore		0.426	0.285		0.410
Norfolk			0.289		
Charleston	0.709		0.183		
Huntington	0.706		0.190		
EAST NORTH CENTRAL					
Chicago			0.272		0.243
Gary			0.249		0.257
Indianapolis			0.230		
Detroit			0.282		
Flint					
Akron			0.213		
Cincinnati			0.206		
Cleveland			0.247		
Steubenville	0.673		0.185		
Toledo	0.679		0.273		0.266
Milwaukee	0.690		0.293		0.350
EAST SOUTH CENTRAL					
Birmingham			0.265		
Louisville			0.186		0.216
Chattanooga					
Memphis			0.197		0.205
WEST NORTH CENTRAL					
Davenport			0.258		0.275
Kansas City			0.264		0.233
Minneapolis	0.777		0.270		0.240
St. Louis	0.711	0.469	0.198		0.213
Omaha		0.560	0.289		0.252
WEST SOUTH CENTRAL					
New Orleans		0.471		0.193	
Oklahoma City				0.167	
El Paso		0.373		0.274	
Houston		0.321		0.197	
MOUNTAIN					
Phoenix				0.298	
Denver		0.397	0.228		0.221
Salt Lake City		0.248	0.270		0.263

Exhibit I-5, cont'd

Mean 1966 Prices[1] Per Million BTU
To Power Plants[2] For Coal, Fuel Oil,
And Natural Gas In Surveyed Metropolitan Areas

District/ Metropolitan Areas	Fuel Oil [3]		Coal [3]	Natural Gas [3]	
	Light Grades	Heavy Grades		Firm	Interruptible
PACIFIC					
Los Angeles	$	$0.309	$	$	$0.305
San Francisco					0.330
Portland		0.378			0.360
Seattle					
HAWAII					
Honolulu					

1/ Source: National Coal Association, Steam Electric Plant Factors - 1966 (Washington, D. C., 1967).

2/ Steam electric generating stations operated by public or municipal utility (see page V-1).

3/ No entry implies no power plants in city in 1966, this fuel not used by power plants in city, or information confidential (see footnote 1).

CHAPTER II - SURVEY OF COAL PRICES

This chapter gives estimates of the cost of coal in selected cities across the United States in the spring of 1968. Coal price data were obtained from published sources and from coal dealers; freight rates were obtained from coal dealers and from government and industry sources. None of the data were independently verified by Ernst & Ernst for accuracy and freedom from bias.

The purpose of the survey was to obtain coal prices in dollars per million BTU to domestic, commercial, and industrial users. A domestice price was defined as the price of coal delivered on one- to four-ton lots, a commercial price as the price for four- to twelve-ton lots, and an industrial price, the price of coal delivered in rail car lots. Little information is available on coal sold to domestic and commercial users, however. Therefore, the results reported are comprehensive only for industrial user prices.

METHODOLOGY

Coal price data were obtained in two ways. First, during the period March-June 1968, retail and wholesale dealers in more than half of the selected cities were asked the characteristics of the coal they sell--sulfur, ash, and heat content--the price per ton f.o.b. mine, and the freight rate for a ton of coal from the mine to the city.

Second, because the survey did not provide adequate information, a method was developed to calculate the prices of the various grades of coal in the selected cities: (1) the sulfur and heat contents and the estimated price per ton f.o.b. mine were obtained by district for each of the twenty-three coal districts with significant production; (2) freight prices were

obtained for transporting one rail car of coal from the nearest coal-producing district to each of the cities of the survey; (3) freight prices were obtained for transportation of coal to each city from the nearest district producing low sulfur coal; and (4) the estimated coal prices at minemouth and the appropriate freight rates were added to obtain the calculated price in each city of the nearest and most easily obtainable coal, whatever the sulfur content, and of low sulfur content coal from the nearest district producing low sulfur coal.

SOURCES AND ASSUMPTIONS

Dealer Survey Prices

Coal dealers in a number of cities were surveyed by telephone for coal prices, sulfur and heat content, and freight rates. The telephone survey was supplemented by additional information for Philadelphia and New York, obtained by F.A. Rohrman, formerly of the U.S. Public Health Service. The information appears in a memorandum dated February 2, 1967.

Calculated Coal Prices

The calculated coal prices are based on the assumption that the estimated price f.o.b. mine plus transportation comprise the price of coal in a city. The calculated coal prices were derived from four principal sources:

(1) The estimated prices for coal f.o.b. mine are based on 1966 Bureau of Mines published data increased by six percent on the basis of preliminary 1967 cost estimates provided by the Bureau. No data were available on appropriate price adjustments for the first half of 1968. The adjusted 1966 data were assumed to apply to the period of the survey (March-June 1968). The 1966 prices are published in Mineral Industry Survey, Bureau of Mines Weekly Coal Report No. 2609 (September 15, 1967).

(2) Most of the freight rates were obtained from Interstate Commerce Commission publications, from industry sources, and from F.A. Rohrman, the U.S. Public Health Service. Some were received from the coal dealers surveyed by telephone.

(3) The sulfur contents of coal by district were taken from Sulfur Content of United States Coals, Bureau of Mines Information Circular 8312, by Joseph A. De Carlo et al, (U.S. Department of the Interior, 1966). The sulfur contents are based on 1964 data, the most recent obtainable. It was assumed that sulfur contents have not changed appreciably since 1964.

(4) The ranges of heat content in BTU per pound were taken from the Keystone Coal Buyer's Manual (McGraw-Hill, 1968) and Analysis of Tipple and Delivered Samples of Coal Collected During Fiscal Year 1967, S.S. Aresco and J.B. James, Bureau of Mines Report of Investigation 7104 (U.S. Department of the Interior, 1968). The latter gives BTU ranges for coal purchased by the Federal Government in 1967. These two sources are not in complete agreement, and only the latter contains both heat content and production data. Both sets of data were used and weighted with available production figures.

FINDINGS

Calculated Prices

Exhibit II-1 shows sulfur and heat contents of coal by producing district and estimated prices f.o.b. mine. The sulfur contents shown are means of the sulfur contents of the coal of each county within a district; the means were weighted by the counties' production relative to total district production. The heat contents are shown as ranges in almost all cases because of the variation found within each district.

Exhibit II-2 shows rail freight rates to each city from at least one low sulfur district (Districts 7 or 8) and, where applicable, from local coal districts producing higher sulfur coal. Ranges in prices and multiple entries for freight rates for coal from one district to a city reflect the variation in price depending on the part of the district from which the coal originates. It was found after completion of the survey that in several cities lower rates are available through the use of truck and barge transport. Some truck and barge rates appear in the exhibit and are indicated. However, there may exist other cities for which the freight rates shown are higher than typical.

Exhibit II-3 shows the calculated estimated prices and price ranges for coal from Districts 7 and 8, low sulfur coal-producing districts, and from the nearest coal-producing district or districts to each city. These prices are the sums of the estimated coal prices f.o.b. mine by district (Exhibit II-1) and the appropriate freight rates (Exhibit II-2). Where no prices are given, data were unobtainable, presumably because coal is not used or is used only rarely in that city.

Special costs such as unloading charges, freight from public siding to the consumer's own siding, or the fees of a broker are not included in these estimated prices. Nor was any attempt made to predict possible future fluctuations in price.

Exhibit II-4 shows the ranges in price of delivered coal in cost per million BTU and the average sulfur content of coal from the origin district for the respective cities. These prices were derived from the cost per ton of delivered coal (Exhibit II-3) divided by the heat contents of the coal from the appropriate district (from Exhibit II-1). The "high" and "low"

prices represent only the high and low encountered in the data, not necessarily the absolute high and low prices for the cities indicated.

Actual or future prices paid for low sulfur coal may vary appreciably from the study results. This is because, according to suppliers, low sulfur coal (less than one percent by weight) for non-metallurgical uses is unobtainable at present in most cities. Thus, a sizable demand for low sulfur coal for steam and space heating would create a new market and could cause a considerable price increase. Because of the difference in price between metallurgical and non-metallurgical coal, an analysis was carried out to measure the contribution of the price of metallurgical coal to the total price at minemouth in each district. Removing the metallurgical coal price from the total coal price effected no significant change as compared with the coal prices per million BTU shown in Exhibit II-4.

Dealer Survey Prices

The data obtained from the survey of coal dealers are shown in Exhibit II-5. In general, dealers were able to give sulfur, heat, and ash content, price per ton f.o.b. mine, and freight rates for coal purchased by industrial users (in rail car lots).

The exhibit also contains some prices for coal to domestic users (one- to four-ton lots purchased) and commercial users (four- to twelve-ton lots purchased). In the cities surveyed more than half of the retail coal dealers contacted had discontinued their coal business. Of the dealers still selling coal only a few were able to supply any information on their product other than price. Sulfur and heat contents were unavailable in most cases. For this reason there are very few entries in the exhibit for domestic and commercial prices.

The exhibit is supplemented in the cases of Philadelphia and New York by survey information gathered by F.A. Rohrman, formerly of the U.S. Public Health Service (see "Sources and Assumptions" and the footnotes to the exhibit).

EXHIBIT II-1

SULFUR AND HEAT CONTENTS AND ESTIMATED PRICES
OF COAL BY COAL PRODUCING DISTRICT

Coal-Producing District[1]	Mean Sulfur Content (%)	Heat Content BTU/pound	Estimated 1968 Mean Price per ton f.o.b. mine[2]
1. Eastern Pennsylvania	2.0	11,700-14,500	$4.59
2. Western Pennsylvania	1.8	11,700-14,300	6.33
3. Northern West Virginia	2.0	13,850	4.93
4. Ohio	3.3	11,600-13,600	4.02
6. Panhandle	3.6	13,900	4.54
7. Southern Numbered 1	0.7	14,000-15,000	6.51
8. Southern Numbered 2	0.9	12,200-14,800	4.71
9. West Kentucky	3.7	12,300-13,000	3.66
10. Illinois	3.0	10,400-12,800	4.08
11. Indiana	2.9	10,800-11,900	4.16
12. Iowa	4.5	9,000-10,100	3.91
13. Southeastern	1.1	12,200-14,600	7.17
14. Arkansas-Oklahoma	2.0	13,200-14,600	7.74
15. Southwestern	3.6	11,200-13,100	4.55
16. Northern Colorado	0.7	9,000-10,700	4.45
17. Southern Colorado	0.7	10,700-13,200	5.67
18. New Mexico	0.7	10,200-13,500	2.67
19. Wyoming	0.7	7,400-12,800	3.43
20. Utah	0.8	12,100-13,000	6.12
21. North-South Dakota	0.8	7,000	2.10
22. Montana	0.7	9,100	3.27
23. Washington	0.7	10,600-11,600	8.03

1/ District 5, Michigan, is deleted because it no longer produces significant amounts of coal.

2/ Universal Industry Surveys, Weekly Coal Report No. 2609 (U.S. Department of the Interior, Bureau of Mines, September 15, 1967). Price data from this publication were increased by six percent uniformly in accordance with preliminary 1967 and 1968 data.

EXHIBIT II-2

FREIGHT RATES FROM COAL-PRODUCING DISTRICTS[1/]
TO SURVEYED METROPOLITAN AREAS

(1968 rates for one rail car lot in dollars per ton)

Destination	Freight Rate (District No.)	District 7 (low sulfur) Freight Rate	District 8 (low sulfur) Freight Rate)
NEW ENGLAND			
Hartford	$ 5.49(1)	$ 6.92	$7.19-7.32
"	5.71(3)		
Boston	5.94(1)	7.15-8.02	7.42-8.43
Providence	5.92(1)	7.04	7.31-7.44
MIDDLE ATLANTIC			
Buffalo	4.00(1)[2/3/]	5.65	4.75[2/]
"	3.95(1)		5.45
"	5.25(8)[2/]		
"	3.91(3)		
New York	4.90(1)[4/]	6.16	6.43-6.56
" "	4.93-5.27(1)	4.75[5/]	6.41[4/]
" "	4.15-5.49(3)		6.70
Syracuse	4.71(1)	5.49-5.83	5.76-6.28
Allentown	4.71(1)	5.70[4/]	5.90[4/]
Philadelphia	4.41(1)[4/]	5.48-5.82	5.75-6.23
"	4.69(1)		
"	4.31-4.81(3)[2/]		
"	4.93(3)	5.04	4.94
Pittsburgh	4.56(1)		
"	4.75(3)[2/]		
"	4.81(3)		
"	5.10-5.50(8)[2/]		
"	0.50-1.25(2)[2/3/]		

Freight Rates from Coal-Producing Districts[1] to Surveyed Metropolitan Areas

Destination	Freight Rate (District No.)	District 7 (low sulfur) Freight Rate	District 8 (low sulfur) Freight Rate
SOUTH ATLANTIC			
Wilmington	$4.56-4.69(1)	$5.48-5.82	$5.75-6.23
"	4.81-4.93(3)		
Washington	4.56(1)	4.97	5.19-5.37
"	4.81(3)		
Jacksonville	6.40(9)	6.02	5.77-6.12
Miami	7.90(9)	7.45	7.29-7.54
Atlanta	4.75(9)	5.78	4.75-5.88
Baltimore	4.32(1)	5.39	5.65-5.79
Norfolk	Use District 7 or 8 rate	4.72	4.82-5.02
"		4.27[2]	
Charleston	" " " " "	2.30-2.54	1.03-2.72
Huntington	" " " " "	2.54-3.35	1.81-3.20
EAST NORTH CENTRAL			
Chicago	4.32(9)[2]	5.46	5.26
"	2.59-3.80(10)		
"	1.61-3.95(10)		
"	2.79(10)[2]		
"	3.28-3.67(11)		
"	3.45(11)[2]		
Gary	2.59-3.80(10)	5.46	5.26
Indianapolis	1.94(11)[2]	4.78	4.68
"	1.69-2.66(11)		
"	1.50(11)[2]		
Detroit	4.14-4.25(4)	5.01	4.75-4.76
"	4.25(4)[2]		
Flint	4.47-4.57(4)	5.32	5.07
"	4.57(4)[2]		

Freight Rates from Coal-Producing Districts[1/]
to Surveyed Metropolitan Areas

Destination	Freight Rate (District No.)	District 7 (low sulfur) Freight Rate	District 8 (low sulfur) Freight Rate
EAST NORTH CENTRAL (Cont'd)			
Akron	Rates not obtained	$ 4.77	$ 4.52
Cincinnati	$2.44-4.25(4)	3.47[2/]	3.36[2/]
"	4.24(2)	3.47	3.24-3.36
Cleveland	2.72-2.99(4)	4.77	4.52
Steubenville	Use District 7 or 8 rates	4.77	4.52
Toledo	3.21-3.34(4)	4.17-4.77	3.92-4.52
Milwaukee	3.25-4.29(10)	6.21	6.01
"	3.90-4.97(11)		
EAST SOUTH CENTRAL			
Birmingham	4.60(9)	4.97-5.37	5.07-5.47
"	1.47(13)[2/]		
Louisville	1.74(9)	3.87	3.26-3.76
Chattanooga	4.39(9)	4.52-4.87	4.52-4.97
Memphis	3.69(9)	5.82	5.82
"	3.30(9)[2/5/]		
WEST NORTH CENTRAL			
Davenport	7.40-8.05(17)	6.52	6.37
"	2.67-4.04(10)		
"	3.92-4.23(11)		
"	6.65-7.30(19)		
Kansas City	4.79-5.46(10)	7.90	7.75
" "	5.30-7.40(17)		
Minneapolis	2.80(10)[2/6/]	7.77	7.62
"	4.96-5.82(10)		
"	7.40-8.55(17)		
"	6.65-7.30(19)		

Freight Rates from Coal-Producing Districts[1] to Surveyed Metropolitan Areas

Destination	Freight Rate (District No.)	District 7 (low sulfur) Freight Rate	District 8 (low sulfur) Freight Rate
WEST NORTH CENTRAL (Cont'd)			
St. Louis	$ 2.93(9)	$ 5.44	$ 5.29
" "	2.21-2.89(10)		
Omaha	5.39-5.69(10)	7.90	7.75
"	5.95-7.35(19)		
"	6.05-7.75(17)		
WEST SOUTH CENTRAL			
New Orleans	Rates not obtained	Rates not obtained	Rates not obtained
Oklahoma City	4.34-5.59	" " "	" " "
El Paso	Rates not obtained - negligible coal consumption		
Houston	" " "	" " "	
MOUNTAIN			
Phoenix	" " "	" " "	
Denver	1.71-1.89(16)	10.22-10.47	
"	3.16-5.41(19)		
Salt Lake City	3.23(20)[2]	12.75	12.75
" " "	3.08-3.74(20)		
" " "	4.10-4.81(17)		
PACIFIC			
Los Angeles	7.95-8.05(20)	14.15	14.15
" "	8.70-8.95(17)		
San Francisco	7.32(20)	14.15	14.15
" "	8.70-9.35(17)		
" "	7.95-8.05(20)		
Portland	7.20(20)[2]	14.15	14.15
"	7.60-8.05(17)		
"	6.85-7.15(20)		

Freight Rates from Coal-Producing Districts[1/]
to Surveyed Metropolitan Areas

Destination	Freight Rate (District No.)	District 7 (low sulfur) Freight Rate	District 8 (low sulfur) Freight Rate)
PACIFIC (Cont'd)			
Seattle	$7.05-7.35(20)	$ 14.15	$ 14.15
"	7.80-8.25(17)		
HAWAII			
Honolulu	Rates not obtained - negligible coal consumption		

1/ Unless otherwise noted (footnotes 2 and 4), data sources were Interstate Commerce Commission published rate tables and industry sources. A range in price indicates variations dependent on the size of the district.

2/ Telephone survey taken March-June 1968.

3/ Truck.

4/ F.A. Rohrman (U.S. Public Health Service), "Information on Imported Residual Oil - 1966," Memo of June 5, 1967.

5/ Barge and rail.

6/ Barge $1.83 + rail $0.97 = $2.80 total.

EXHIBIT II-3

ESTIMATED MEAN INDUSTRIAL PRICES PER TON OF COAL
DELIVERED FROM ORIGIN DISTRICT[1]

(March-June 1968)

Metropolitan Area	Price (District No.)	District 7 Price (low sulfur)	District 8 Price (low sulfur)
NEW ENGLAND			
Hartford	$ 10.08(1)	$ 13.43	$11.90-12.03
"	10.64(3)		
Boston	10.53(1)	13.66-14.53	12.13-13.14
Providence	10.51(1)	13.55	12.02-12.15
MIDDLE ATLANTIC			
Buffalo	8.54-8.59(1)	12.16	9.46-10.16
"	8.84(3)		
New York	9.49-9.86(1)	11.26-12.67	11.12-11.27
" "	10.08-10.42(3)		
Syracuse	9.30(1)	Rates not obtained	11.41
Allentown	9.30(1)	12.00-12.34	10.47-10.99
Philadelphia	9.00-9.28(1)	11.99-12.33	10.46-10.94
"	9.24-9.86(3)		
Pittsburgh	9.15(1)	11.55	9.65-10.21
"	6.83-7.58(2)		
"	9.68-9.74(3)		
SOUTH ATLANTIC			
Wilmington	9.15-9.28(1)	11.99-12.33	10.46-10.94
"	9.74-9.86(3)		
Washington	9.15(1)	11.48	9.90-10.08
"	9.74(3)		
Jacksonville	10.06(9)	12.53	10.48-10.83
Miami	11.56(9)	13.96	12.00-12.25

Estimated Mean Industrial Prices Per Ton of Coal
Delivered from Origin District[1]

Metropolitan Area	Price (District No.)	District 7 Price (low sulfur)	District 8 Price (low sulfur)
SOUTH ATLANTIC (Cont'd)			
Atlanta	$ 8.41 (9)	$ 12.29	$ 9.46-10.59
Baltimore	8.91 (1)	11.90	10.36-10.50
Norfolk	Use District 7 or 8 rate	10.78-11.23	9.53-9.73
Charleston	" " " " "	8.81-9.05	5.74-7.43
Huntington	" " " " "	9.05-9.86	6.52-7.91
EAST NORTH CENTRAL			
Chicago	7.98 (9)	11.97	9.97
"	5.69-8.03 (10)		
"	7.44-7.83 (11)		
Gary	6.67-7.88 (10)	11.97	9.97
Indianapolis	5.66-6.82 (11)	11.29	9.39
Detroit	8.16-8.27 (4)	11.52	9.46-9.47
Flint	8.49-8.59 (4)	11.83	9.78
Akron	Rates not obtained	11.28	9.23
Cincinnati	6.46-8.27 (4)	9.98	7.95-8.07
"	10.57 (2)		
Cleveland	6.74-7.01 (4)	11.28	9.23
Steubenville	Use District 7 or 8 rate	11.28	9.23
Toledo	7.23-7.36 (4)	10.68-11.28	8.63-9.23
Milwaukee	7.33-8.37 (10)	12.72	10.72
"	8.06-9.13 (11)		
EAST SOUTH CENTRAL			
Birmingham	8.26 (9)	11.48-11.88	9.78 10.18
"	8.64 (13)		
Louisville	5.40 (9)	10.38	7.97-8.47
Chattanooga	8.05 (9)	11.03-11.38	9.23-9.68
Memphis	6.96-7.35 (9)	12.33	10.53

Estimated Mean Industrial Prices Per Ton of Coal
Delivered from Origin District 1/

Metropolitan Area	Price (District No.)	District 7 Price (low sulfur)	District 8 Price (low sulfur)
WEST NORTH CENTRAL			
Davenport	$ 6.75-8.12-(10)	$ 13.03	$ 11.08
"	8.08-8.39(11)		
"	13.07-13.72(17)		
"	10.08-10.73(19)		
Kansas City	8.87-9.54(11)	14.41	12.46
" "	10.97-13.07(17)		
Minneapolis	6.88-9.90(10)	14.28	12.33
"	13.07-14.22(17)		
"	10.08-10.73(19)		
St. Louis	6.59(9)	11.95	10.00
" "	6.29-6.97(10)		
Omaha	9.47-9.77(10)	14.41	12.46
"	11.72-13.42(17)		
"	9.38-10.78(19)		
WEST SOUTH CENTRAL			
New Orleans	Rates not obtained	Rates not obtained	Rates not obtained
Oklahoma City	12.08-13.33(14)	" " "	" " "
El Paso	Rates not obtained - negligible coal consumption		
Houston	" " "	" " "	
MOUNTAIN			
Phoenix	" " "	" " "	
Denver	6.16-6.34(16)	16.73-16.98	Rates not obtained
"	6.59-8.84(19)		
Salt Lake City	9.20-9.86(20)	19.26	17.46
" " "	9.77-10.48(17)		

Estimated Mean Industrial Prices Per Ton of Coal
Delivered from Origin District 1/

Metropolitan Area	Price (District No.)	District 7 Price	District 8 Price
PACIFIC			
Los Angeles	$14.07-14.17(20)	$ 20.66	$ 18.86
" "	14.62(17)		
San Francisco	13.44-14.17(20)	20.66	18.86
" "	14.37-15.02(17)		
Portland	12.97-13.32(20)	20.66	18.86
"	13.27-13.72(17)		
Seattle	13.17-13.47(20)	20.66	18.86
"	13.37-13.92(17)		
HAWAII			
Honolulu	Rates not obtained - negligible coal consumption		

1/ An industrial price is the price of coal purchased in rail car lots. The prices shown are based on 1966 published f.o.b. mine prices (Bureau of Mines Weekly Coal Report No. 2609 (September 15, 1967)) increased uniformly by six percent on the basis of preliminary 1967 and 1968 data. The prices f.o.b. mine were added to 1968 freight rates. The freight rates are rates to public siding, not necessarily to the consumer's own siding. No costs were added for switching rail cars, unloading, or the fee of a middle man.

EXHIBIT II-4

INDUSTRIAL COAL PRICES PER MILLION BTU

District/Metropolitan Area	Mean Sulfur Content							
	Less than 0.7%		0.8-0.9%		1.8-2.0%		2.9-3.7%	
	Low	High	Low	High	Low	High	Low	High
NEW ENGLAND								
Hartford	$0.45	$0.48	$0.41	$0.49	$0.35	$0.43	$	$
Boston	0.48	0.49	0.44	0.50	0.36	0.45		
Providence	0.45	0.48	0.41	0.49	0.36	0.45		
MIDDLE ATLANTIC								
Buffalo	0.41	0.43	0.34	0.39	0.30	0.36		
New York	0.40	0.42	0.38	0.46	0.34	0.41		
Syracuse			0.39	0.47	0.32	0.40		
Allentown	0.41	0.43	0.37	0.43	0.32	0.40		
Philadelphia	0.41	0.43	0.37	0.43	0.32	0.38		
Pittsburgh	0.39	0.41	0.34	0.40	0.27	0.39		
SOUTH ATLANTIC								
Wilmington	0.41	0.43	0.37	0.45	0.32	0.39		
Washington	0.38	0.41	0.34	0.41	0.32	0.39		
Jacksonville	0.42	0.45	0.37	0.43			0.39	0.41
Miami	0.47	0.50	0.41	0.49			0.44	0.47
Atlanta	0.41	0.44	0.36	0.39			0.32	0.34
Baltimore	0.40	0.43	0.35	0.42	0.31	0.38		
Norfolk	0.37	0.39	0.33	0.39				
Charleston	0.30	0.31	0.24	0.25				
Huntington	0.32	0.33	0.27	0.27				
EAST NORTH CENTRAL								
Chicago	0.40	0.43	0.34	0.41			0.27	0.34
Gary	0.40	0.43	0.34	0.41			0.31	0.32
Indianapolis	0.38	0.40	0.32	0.38			0.26	0.29
Detroit	0.38	0.41	0.32	0.39			0.30	0.35
Flint	0.39	0.42	0.33	0.40			0.32	0.37
Akron	0.38	0.40	0.31	0.38				
Cincinnati	0.33	0.36	0.27	0.33	0.37	0.45	0.28	0.30
Cleveland	0.38	0.40	0.31	0.38			0.26	0.29
Steubenville	0.38	0.40	0.31	0.38				
Toledo	0.38	0.38	0.31	0.35			0.27	0.31
Milwaukee	0.42	0.45	0.36	0.44			0.33	0.38
EAST SOUTH CENTRAL								
Birmingham	0.40	0.41	0.34	0.40	0.30[2/]	0.35[2/]	0.32	0.34
Louisville	0.35	0.37	0.29	0.33			0.21	0.22
Chattannoga	0.38	0.39	0.33	0.38			0.31	0.33
Memphis	0.41	0.44	0.36	0.43			0.28	0.28

Exhibit II-4 (Cont'd)

Industrial Coal Prices per Million BTU

District/Metropolitan Area	Mean Sulfur Content							
	Less than 0.7%		0.8-0.9%		1.8-20%		2.9-3.7%	
	Low	High	Low	High	Low	High	Low	High
WEST NORTH CENTRAL								
Davenport	$0.42	$0.68	$0.37	$0.45	$	$	$0.32	$0.37
Kansas City	0.48	0.51	0.42	0.51			0.37	0.43
Minneapolis	0.42	0.63	0.42	0.51			0.33	0.39
St. Louis	0.40	0.43	0.34	0.41			0.25	0.30
Omaha	0.42	0.63	0.42	0.51			0.38	0.46
WEST SOUTH CENTRAL								
New Orleans								
Oklahoma					0.46	0.46		
El Paso								
Houston								
MOUNTAIN								
Phoenix								
Denver	0.30	0.60						
Salt Lake City	0.40	0.69	0.38	0.72				
PACIFIC								
Los Angeles	0.55	0.74	0.55	0.77				
San Francisco	0.57	0.74	0.55	0.77				
Portland	0.52	0.74	0.51	0.77				
Seattle	0.53	0.74	0.52	0.77				
HAWAII								
Honolulu								

1/ See Exhibit II-3 for the sources of the estimated 1968 prices per ton of coal. No entry indicates insufficient information obtained, presumably because a city does not use the particular grade of coal or a significant amount of any coal. The "high" and "low" values represent only the extremes encoutered in the data; they do not necessarily represent the highest and lowest prices in the areas indicated.

2 District 13 coal averages 1.1% sulfur.

EXHIBIT II-5

PRICE AND SULFUR, ASH, AND HEAT CONTENT DATA OBTAINED FROM COAL DEALERS[1]

Period of Survey: March-June 1968

District/Metropolitan Area	Origin District	Sulfur Content %	Ash Content %	Heat Content BTU/Pound	Price per Ton			Freight (Unit Train Discount (utd), Other Charges)
					Domestic	Commercial	Industrial (f.o.b.Mine)	
NEW ENGLAND								
Boston	Anthracite	Less than 0.3	6.0-7.0	14.500	$ 32.95	$ 27.95	$	$
"	7	Less than 0.85	2.5-7.0	15,000-14,300			Over 7.00	
MIDDLE ATLANTIC								
Buffalo	8	Less than 0.7	4.5	14,000			5.75	4.75
"								0.40 utd
"								0.50 ton unloading
"							4.50	4.00
"	1						4.70-5.00	3.91
"	3	2.0-4.0	7.0	13.600			5.25-6.25	4.75[3]
New York	7	Less than 1.0	4.0-6.0	13,700-13,800			4.25-4.60	
" "	1	1.5-2.5	9.0-11.0	13,000-13,300			4.90-5.50	
" "	1	1.5-2.5	8.0-9.0	13,600-13,800			4.75-5.25	
" "	2	1.5-2.5	8.0-9.0	13,400-13,600			4.50-5.25	
" "	3	0.8-3.0	6.0-10.0	13,300-13,800			5.00-5.50	
" "	7, 8	0.8-1.3	6.0-8.0	13,400-13,700			6.00	6.41
" " [2]	8	0.9	6.0-7.0	13,400-14,100[4]			7.00	6.01; 0.50-1.50 utd
" " [2]	7	0.5-0.8	3.0	14,100-14,600[4]			3.03-3.73	4.90; 0.50-1.50 utd
" " [2]	1	2.5-3.5	9.0-12.0	12,400-13,400[4]			7.00	5.70; 0.50-1.50 utd
Philadelphia [2]	7	0.3-0.8	4.0-7.0	14,100-14,600[4]			3.30	4.41; 0.50-1.50 utd
" [2]	1	1.5-3.5	11.0	12,400-13,400[4]			6.00	5.90
" [2]	8	0.9	6.0-7.0	13,400-14,100			4.75	4.31-4.81; 0.8 -1.31 utd
"	8	2.5	7.0	13,600			4.75	4.75; 1.50 utd
Pittsburgh	3						6.00	5.10-5.50
"	8						5.00-6.25	0.50[5]
"	2	2.0-2.5	7.0-8.0	13,500			4.50-5.50	1.25[5]
"	2		7.0-7.5	13,600			5.00-6.25	1.00[2]
"	2	1.3	7.0-8.5	13,500				
SOUTH ATLANTIC								
Wilmington	Anthracite				26.75			
Washington	7				24.75			
"	Anthracite				33.00			
Jacksonville	7	4.0		14,000	26.00-28.00			
Atlanta	9				21.40			
Baltimore	Anthracite			13,000	21.50-23.75			
"	3	1.5-1.7	Less than 10.0	13,200-13,600			4.56	1.35 utd
Norfolk	7	Less than 1.0	7.0	13,800			5.50	4.27
"	7	Less than 1.0	7.0	13,800	6.50 fobm[6]	6.50 fobm[6]		4.27
EAST NORTH CENTRAL								
Chicago	8	Less than 1.5	3.0-4.0	14,200-14,300		16.00-16.50		
"	10	Over 2.5	5.0-6.0	11,500			3.50-3.75	2.79 (5.50 from Dist. 8)

Exhibit II-5 (Cont'd)

Price and Sulfur, Ash, and Heat Content Data Obtained From Coal Dealers[1/]

District/Metropolitan Area	Origin District	Sulfur Content %	Ash Content %	Heat Content BTU/Pound	Domestic	Commercial	Industrial (f.o.b.mine)	Freight (Unit, Train Discount (utd), Other Charges)
EAST NORTH CENTRAL (Cont'd)								
Chicago	9	Over 3.0	6.0-8.5	12,200-12,500	$	$	$ 4.35	$4.32; 0.50-1.00 utd
"	11	Over 3.0	8.0	11,400-11,500			4.30	3.45
"	10	Over 3.0	8.0-8.5	12,000-12,500			4.50	3.95; 0.50-1.00 utd
"	10	Over 3.0	5.0	11,600-11,700			4.75	1.61 3/
"	10	3.5	8.0-9.0	10,300-10,400			Less than 4.00	1.61 3/
Indianapolis	11	3.5	9.0	11,900			4.50	1.94
"	11	3.0-4.0	6.0-9.0	12,500-13,000			3.75	1.50
Detroit	4	3.0-3.5	7.5-8.5	12,800			4.75	4.25
Flint	4	3.0-3.5	7.5-8.5	12,800			4.75	4.57
"	8	0.5	2.5-5.0	14,370	25.00		13.50-14.00	
"	Anthracite	0.5	4.5-5.5	15,200	25.45	20.70		
Akron	8	0.73	2.75	14,200	17.75-18.50			
"	4	2.5	5.0-6.0	13,500	15.50			
Cincinnati	7	Less than 1.0	4.5-5.0	14,000-14,600			6.00	3.47
"	8	Less than 1.0	4.0-8.0	12,000-13,300			4.25-5.00	3.36
Cleveland	8	Less than 1.0	6.0-8.0	12,900-13,200	20.00-25.00		4.30-4.50	
"	1	2.0-2.5	6.0-8.0	12,500-12,800			4.00	
"	4	3.8 4.0	6.0-8.0	12,200-12,500			3.80	
"	2	2.0-3.0		13,400			4.85-5.25	
"	4	2.7-4.5	7.5-9.0	12,900			4.60-5.10	
Milwaukee					30.00-37.00	17.00-25.00		
EAST SOUTH CENTRAL								
Birmingham	13	1.0-1.1	Less than 3.0	14,400-14,500			7.25-8.00	1.47
Louisville	8	1.2	5.0	13,600			6.25	3.00
Memphis						15.00-20.00		
"	10	3.5	11.5	11,200			4.99	
"	9	3.5	9.0	12,100			4.90	
WEST NORTH CENTRAL								
Minneapolis-St. Paul	10	3.0	9.0	11,200			4.35	2.80 3/
St. Louis		1.1	6.0-7.0	15,500	24.00-26.00	21.00-24.00		
MOUNTAIN								
Denver	16, 17	0.3-0.4	3.5	13,200	16.00-18.00		8.00-14.00	
Salt Lake City	20	0.4-0.5	6.0-8.0	13,300-13,600			6.05	3.23
PACIFIC								
San Francisco	20	0.4-0.5	6.0-8.0	13,300-13,600			6.05	7.32
Portland	20	0.4	6.0-12.0	12,900-13,200			7.10	7.20

1/ All data from surveyed dealers are shown. A non-entry for sulfur, only, or heat content or origin district indicates that the dealer could not provide the information requested. Few dealers still sell coal in domestic (one- to four-ton lots) and commercial (four- to twelve-ton lots) quantities. Hence, there are few prices in those columns. An industrial price is the price for coal purchased in rail car lots.

2/ F.A. Rohrman, U.S. Public Health Service,"Information on Imported Residual Oil - 1966," (Memo of June 5, 1967).

3/ Barge and rail.

4/ BTU extrapolated from S.J. Aresco and J.B. James, Analyses of Tipple and Delivered Samples of Coal, Bureau of Mines Report of Investigation 7104 (U.S. Department of the Interior, 1968).

5/ Freight rate/ton (truck).

6/ Wholesale price.

CHAPTER III - SURVEY OF FUEL OIL PRICES

The purposes of this chapter are (1) to give prices of the various grades of fuel oil across the United States and (2) to give the sulfur contents of the fuel oils currently used. Fuel oil grade nos. 1, 2, 4, 5, and 6 (PS 100, PS 200, 4, PS 300, and PS 400, respectively, on the West Coast) were included in the survey. Where available, prices were obtained for fuel oil sold to domestic, commercial, and industrial users. A domestic price is the price of fuel oil purchased in quantities of 100 to 200 gallons; a commercial price, the price for quantities of 1,000 to 2,500 gallons; an industrial price, the price for quantities of 6,000 to 12,000 gallons.

Prices were obtained from published sources and from fuel oil dealers. None of the prices were independently verified by Ernst & Ernst. By comparing published and dealer prices, it was possible to extrapolate some prices not otherwise obtainable. This chapter, however, contains only data from published sources and dealers. Extrapolated data were used to complete the summaries of prices shown in Chapter I.

FUEL OIL PRICES

METHODOLOGY

Three published sources of fuel oil prices were consulted. Next, fuel oil dealers in twenty-eight of the urban areas considered in the study were contacted for price information. The survey of fuel oil dealers provided prices for cities not included in the lists of published prices. Further, the survey was the basis of assumptions for determining variations in price to domestic and commercial users from published rack (i.e., f.o.b.

bulk plant, or industrial) prices.

Finally, the prices were calculated with respect to heat content. The resulting prices per million BTU are presented in the summary exhibits of Chapter I.

SOURCES AND ASSUMPTIONS

Fuel Oil Price Sources

Prices were obtained from four sources:

(1) Fuel oil dealers in twenty-eight cities were surveyed by telephone.

(2) Platt's Oil Price Handbook and Oilmanac 1967, 44th Ed. (New York, 1968).

(3) Platt's Oilgram Price Service, Vol. 46, No. 102 (New York, May 24, 1968) and Vol. 46, No. 108 (June 4, 1968).

(4) The Oil Daily (New York, June 4, 1968).

Assumptions

Where prices appear in more than one source, the first choice for the data was Platt's Oilgram, and The Oil Daily was second. The dealer survey was used to supplement these two sources. The domestic prices were primarily taken from The Oil Daily. The Oil Daily gives prices for large tank wagon quantities; therefore, to obtain more realistic domestic prices, a half-cent a gallon was added to the published price for grade nos. 1 and 2 fuel oils. Most of the rack prices are from Platt's Oilgram.

Heat Content Data Sources

(1) Heat contents were obtained from fuel oil dealers and from private communication with refineries.

(2) National Coal Association, Steam Electric Plant Factors - 1966 (Washington, D.C., 1967).

FINDINGS

Exhibit III-1 summarizes the dealers' quoted prices for fuel to the three classes of users. Summaries of the price data available from both published and dealer survey sources appear as Exhibits III-2 and III-3. Exhibit III-2 shows the rack, or the approximate industrial prices for the several grades of fuel oil. Exhibit III-3 shows the domestic prices of light fuel oils. The prices are given in dollars per barrel (forty-two gallons).

The dealers' domestic prices were about fifty percent greater than the Platt's rack prices, and the dealers' industrial prices were at or near the published rack prices. The published and dealer prices for the two classes of users were compared. The comparison showed the dealers' industrial prices to be within ten percent of Platt's prices and the dealers' domestice prices to be fifty-two percent over the Platt's prices plus or minus six percent of Platt's. The domestic price difference is supported by the prices in The Oil Daily.

For heavier fuel oils, fuel dealers provided commercial (1,000 to 2,500 gallons) prices that were generally twenty to thirty-eight percent above the rack prices. The Oil Daily indicates a markup above rack prices of twenty to twenty-five percent for similar quantities of nos. 5 and 6 fuel oils in the Chicago area. It was concluded, then, that the markup on heavy fuel oils in commercial quantities is twenty-nine percent plus or minus nine percent of Platt's.

Commercial users as defined in this study do not use the lighter fuel oils, grade nos. 1 and 2. It has been uneconomical for users in this range--for example, office buildings, schools, department stores--to burn light fuels. Dealers consider commercial users of light fuels to be those who buy in quantities only somewhat greater than domestic quantities; for a "commercial user" buying 300 to 600 gallon quantities, dealers may charge one-half to one cent a gallon off the domestic prices. If, however,

because of changing circumstances a user wished to buy light fuel oil in 1,000 to 2,500 gallon quantities, it is assumed that the markup over the rack price would be the same as that of heavier fuels: twenty-nine percent plus or minus nine percent of Platt's.

A summary of conclusions based on the published prices, the dealer survey, and comparisons among the prices appears below. These conclusions, or "rules of thumb," were used to derive data for which no published sources were available. Derived fuel oil data appear only in the exhibits to Chapter I.

Fuel	Industrial	Commercial	Domestic
1	Platt's	Platt's + 29%	Platt's + 52%
2	"	"	"
4	"	"	Not applicable
5	"	"	" "
6	"	"	" "
Error	± 10% of Platt's	± 9% of Platt's	± 6% of Platt's

Heat contents appear to vary little among fuel oils. On the basis of concurrence among sources, the following values were chosen as representative when prices per million BTU were calculated. (These prices appear only in the summary exhibits of Chapter I.)

Fuel Oil Grade No.	Million BTU/Barrel
1	5.46
2	5.67
4	6.09
5	6.22
6	6.38

These figures apply to fuel oils with their natural sulfur contents, since desulfurization reduces heat content.

SULFUR CONTENT

METHODOLOGY, SOURCES, AND ASSUMPTIONS

Sulfur contents of the various grades of fuel oils were obtained from published sources.

(1) F.A. Rohrman (U.S. Public Health Service), "Information on Imported Residual Oil - 1966," Memo. of June 15, 1967. The heavy fuel oils which emit most of the sulfur pollutants are mainly imported and are used almost exclusively on the Atlantic and Gulf coasts and to a lesser extent on the Great Lakes. F.A. Rohrman, formerly of the U.S. Public Health Service, made a study of the sulfur content of imported oils using 1966 data. This study, though somewhat out of date, is the most complete source of information on sulfur content of heavy residual fuel oils. The study was based on reports filed with the Oil Import Administration (OIA) of the U.S. Department of the Interior.

(2) The Rohrman study was updated by a review of the OIA files for the month of March 1968. Not all the cities covered in Rohrman's work were reported in that month's file, however.

(3) O.C. Blade, Burner Fuel Oils, 1967, Petroleum Product Survey No. 51 (U.S. Department of the Interior; Bureau of Mines, August 1967). This source gives sulfur contents of domestically refined heavy fuel oils and of light fuel oils.

The Rohrman study and the review of more recent OIA data together give a good estimate of the average sulfur content of residual fuel oil in cities where residual oil is imported.

Where sulfur contents for fuel used in a city appeared in more than one source, the March OIA data was the first choice, the Rohrman study the second, and Burner Fuel Oils, third.

FINDINGS

In Burner Fuel Oils sulfur contents are given by geographical district rather than by city. Exhibit III-4 is a map showing the five districts. Exhibit III-5 shows the common percentages of sulfur in five grades of fuel oils in the five geographical districts.

Exhibit III-6 presents the estimated mean sulfur contents of no. 6 fuel oil in the cities of the study. The data from each of the three sources are given. The estimated mean is not an arithmetic mean of the three estimates from the sources. Rather, it is the mean sulfur percentage from the "best source" available (see preceding section for choice among sources).

EXHIBIT III-1

PRICE, SULFUR, AND HEAT CONTENT 1/
DATA OBTAINED FROM FUEL OIL DEALERS
Period of survey: March-June 1968

District/Metropolitan Area	Fuel Grade	Sulfur Content %	Heat Content in Million BTU per Barrel	Dealer's Price per Barrel			Notes
				Domestic 2/	Commercial 2/	Industrial 2/	
NEW ENGLAND							
Hartford	6			$	$	$2.75-2.77	New Haven price plus $0.36-0.38 per barrel
Boston	2			7.35			
"	4	1.5	6.1			3.51-3.55	
"	5	2.0 max.	6.1				No prices given
"	6	2.2-2.8	6.28			2.39	
MIDDLE ATLANTIC							
Buffalo	1	0.1		7.95-8.35			
"	1			7.94			
"	2	0.1-0.36		7.53-7.95		4.41-5.46	
"	2			7.52			
"	2	0.26	5.85			4.52-4.73	
"	4	0.4	6.17			3.78-4.10	Mean: $3.89
"	5	0.6	6.23			3.57-3.89	Mean: $3.68
"	6	0.9	6.35			3.15-3.36	
Allentown	1	0.25		7.64			Philadelphia price plus transportation of $0.50 per barrel to Bethlehem and $0.51 per barrel to Allentown
"	2	0.25		7.14			
"	6	1.0				3.60	
"	6	2.0-2.5				2.83-2.93	
Philadelphia	1			7.35			
"	2	0.3		6.85			
"	4	0.7			4.25		
"	5				4.02-4.23	3.29	
"	6				3.07-3.28	2.33	
Pittsburgh	1	0.5	5.6	7.88			
"	2	0.5	5.8	7.31			
SOUTH ATLANTIC							
Wilmington	1			7.81			
"	2			7.18			
Washington	1			8.11			
"	2			7.10			
Jacksonville	1			7.98-8.82			
"	2			7.14-8.40			
Norfolk	1			7.64			
"	2			6.80			
Charleston	6	0.4-1.0	6.38-6.47			3.68-3.78	
Huntington	1	0.15					No prices given
"	2	0.25	5.75				" " "
"	6	0.4-1.0	6.38-6.47			3.15-3.36	

(continued)

Exhibit III-1 (Cont'd.)

Price, Sulfur, and Heat Content 1/
Data Obtained from Fuel Oil Dealers
Period of survey: March-June 1968

District/Metropolitan Area	Fuel Grade	Sulfur Content %	Heat Content Million BTU per Barrel	Dealer's Price per Barrel			Notes
				Domestic 2/	Commercial 2/	Industrial 2/	
EAST NORTH CENTRAL							
Chicago	1			$6.97	$	$	
"	2			6.55			
"	2				5.04	3.47-3.78	Tank wagon delivery
"	4	1.07					
"	5	1.0-3.0			4.38		
"	5	1.0-3.0			3.99	3.99	Tank wagon delivery
"	5	1.8-2.05-2.25				3.36-3.68	
"	6	1.2				3.26	
"	6	1.87-2.09-2.5				3.15	
Indianapolis	2	0.2	5.9	6.60			200-400 gallon delivery
Detroit	6	0.85	6.4			3.57	
Flint	1			7.10			
"	2			6.68			
Akron	2	0.19-0.29	5.82-5.88	6.68	6.68		100-3,000 " "
"	2	0.19-0.29	5.82-5.88		5.12		3,000 gallon minimum delivery
Cincinnati	2	0.19-0.29	5.82-5.88	6.68			100-3,000 gallon delivery
"	2	0.19-0.29	5.82-5.88		5.12		3,000 gallon minimum delivery
Cleveland	2	0.19-0.29	5.83	6.68			100-3,000 gallon delivery
"	2	0.19-0.29	5.83		5.12		3,000 gallon minimum delivery
Steubenville	6	0.4-1.0	6.38-6.47			3.47	
Toledo	2	0.19-0.29	5.82-5.88	6.68			100-3,000 gallon delivery
"	2	0.19-0.29	5.82-5.88		5.12		3,000 gallon delivery
EAST SOUTH CENTRAL							
Birmingham	2	0.25	5.9-6.0	7.01		5.04	
Louisville	2	0.09	5.88	7.14			400 gallon minimum delivery
"	2	0.1-0.3	5.67			4.83	
"	2	0.09	5.88			5.25	
Chattanooga	2	0.09	5.88			4.83	5,000 gallon minimum delivery
MOUNTAIN							
Salt Lake City	1	0.13			7.01		
"	2				6.09		
"	6	1.02				2.70	

(continued)

Exhibit III-1 (Cont'd.)

Price, Sulfur, and Heat Content 1/
Data Obtained from Fuel Oil Dealers
Period of survey: March-June 1968

District/Metropolitan Area	Fuel Grade	Sulfur Content %	Heat Content Million BTU per Barrel	Dealer's Price per Barrel			Notes
				Domestic 2/	Commercial 2/	Industrial 2/	
PACIFIC							
Portland	2	0.5 max.		$6.72	$	$	400 gallon minimum delivery
"	5	2.0				3.30	
"	6	2.0	6.3			2.85	" " " "
Seattle	1			8.82			
"	2			7.52			
"	2	0.5		6.80			
"	5				3.89		
"	5	2.0 max.				3.33	
"	6	2.0 max.	6.3			2.88	
HAWAII							
Honolulu	2	0.5 max.		7.14			

1/ All data from surveyed dealers are shown. No entry indicates that the dealer could not provide the information requested.

2/ A domestic price is the price of fuel oil purchased in 100 to 200 gallon quantities. A commercial price is the price of fuel oil purchased in 1,000 to 2,500 gallon quantities. An industrial price is the price for 6,000 to 12,000 gallon quantities.

EXHIBIT III-2

RACK (INDUSTRIAL) PRICES PER BARREL OF FUEL OIL 1/

District/ Metropolitan Area	No. 1	No. 2	No. 4	No. 5		No. 6		Other	Source
				No Sulfur Maximum Guarantee	1% Sulfur Maximum Guarantee	No Sulfur Maximum Guarantee	1% Sulfur Maximum Guarantee		
NEW ENGLAND									
Hartford	$	$	$	$	$	$2.75-2.77	$	$	(d)
Boston	5.21	4.79	3.51-3.55	3.23-3.27		2.34-2.39			(a)
Providence	5.21	4.79	3.34	3.18-3.23		2.38-2.48			
MIDDLE ATLANTIC									
Buffalo		4.91			3.70	3.17	3.42		(a)
New York	5.12	4.70	3.22	2.83		2.28-2.38	2.53-3.10	2.38	(a)
Syracuse									
Allentown						2.83-2.93	3.60		(d)
Philadelphia	5.08	4.66	3.51-3.56	3.29-3.35		2.33-2.43	3.10		(a)
Pittsburgh									(d)
SOUTH ATLANTIC									
Wilmington									
Washington	5.13	4.7				2.32-2.42			
Jacksonville	5.04	4.62				2.35			(a)
Miami	5.63	5.21				2.33			(a)
Atlanta	4.94	4.52							(b)
Baltimore	5.08	4.66	3.39	3.12		2.28-2.38			(a)
Norfolk	5.12	4.70	3.28	2.89		2.30-2.35			(a)
Charleston							3.67-3.78		(d)
Huntington							3.15-3.36		(d)
EAST NORTH CENTRAL									
Chicago	4.41	4.10		3.68	3.89	3.15	3.36	3.57	(a)
Gary									
Indianapolis	4.52-4.73	4.20-4.41							(c)
Detroit	4.66	4.35		3.61	3.72	3.40	3.51		(a)
Flint									
Akron	5.54	5.12							(a)
Cincinnati		5.12							(a)

(Continued)

Exhibit III-2 (Cont'd.)

RACK (INDUSTRIAL) PRICES PER BARREL OF FUEL OIL [1/]

District/ Metropolitan Area	No. 1	No. 2	No. 4	No. 5		No. 6		Other	Source
				No Sulfur Maximum Guarantee	1% Sulfur Maximum Guarantee	No Sulfur Maximum Guarantee	1% Sulfur Maximum Guarantee		
EAST NORTH CENTRAL (cont'd.)	$	$	$	$	$	$	$	$	
Cleveland	5.54	5.12							(a)
Steubenville							3.47		(d)
Toledo	5.54	5.12		3.78		3.57			(a)
Milwaukee	4.77-4.87	4.45-4.56							(c)
EAST SOUTH CENTRAL									
Birmingham	4.94	4.52							(b)
Louisville									
Chattanooga	4.62-4.83	4.20-4.41							(b)
Memphis		4.10		2.50		2.35			(a)
WEST NORTH CENTRAL									
Davenport									
Kansas City	4.62-4.83	4.20-4.41				2.15-2.25			(a)
Minneapolis	4.80-4.91	4.49-4.59		3.89		3.57			(a)
St. Louis	4.58-4.68	4.16-4.26				2.79	2.90		(c)
Omaha	4.70-4.81	4.39-4.49							(b,c)
WEST SOUTH CENTRAL									
New Orleans	4.75-4.83	4.33-4.41		2.83		2.33			(a)
Oklahoma City	4.52-4.62	4.10-4.20				2.10-2.20		2.25-2.35 [5/]	(a)
El Paso									(d)
Houston						2.05-2.30			(a)
MOUNTAIN									
Phoenix									(d)
Denver									(d)
Salt Lake City						2.70			(d)

(continued)

Exhibit III-2 (Cont'd.)

RACK (INDUSTRIAL) PRICES PER BARREL OF FUEL OIL 1/

District/ Metropolitan Area	No. 1	No. 2	No. 4	No. 5		No. 6		Other	Source
				No Sulfur Maximum Guarantee	1% Sulfur Maximum Guarantee	No Sulfur Maximum Guarantee	1% Sulfur Maximum Guarantee		
PACIFIC									
Los Angeles	$4.10	$3.78	$	$ 2.35	$	$1.75	$	$	(a)
San Francisco-Oakland									
Portland				3.30		2.85			(d)
Seattle				3.33		2.88			(d)
HAWAII									
Honolulu						2.82			(d)

1/ Sources:
(a) Platt's Oilgram Price Service (May 24, 1968).
(b) Platt's Oilgram (June 4, 1968).
(c) The Oil Daily (June 4, 1968).
(d) Survey of fuel oil dealers, March-June 1968.
No entry indicates information not obtained.

2/ Maximum 2.2% sulfur.

3/ Maximum 0.6% sulfur.

4/ Platt's Oilgram gives identical rack prices of no. 2 fuel oil for all the Ohio cities it lists (Toledo, Cleveland, Zanesville, Columbus, Dayton). The tank wagon price of no. 2 fuel oil is the same in The Oil Daily for two Ohio cities, Cincinnati and Cleveland. Further, a fuel oil dealer who gave the price of no. 2 fuel oil in Cleveland said that the price would be the same in Cincinnati, Akron, and Toledo as well. It is assumed, therefore, that the price of no. 2 fuel oil in Ohio is the same in all cities.

5/ Maximum 0.75% sulfur.

EXHIBIT III-3

DOMESTIC PRICES PER BARREL OF LIGHT FUEL OIL [2/]

	No. 1	No. 2	Source [2/]
NEW ENGLAND			
Hartford	$	$	
Boston		6.80	(a)
Providence			
MIDDLE ATLANTIC			
Buffalo		7.31	(a)
New York		7.31	(a)
Syracuse			
Allentown	7.64	7.14	(b)
Philadelphia	7.14	7.06	(a)
Pittsburgh	7.46	7.31	(a)
SOUTH ATLANTIC			
Wilmington			
Washington	8.11	7.10	(b)
Jacksonville	7.21	6.93	(a)
Miami	7.35	6.97	(a)
Atlanta			
Baltimore		7.06	(a)
Norfolk	6.30	5.67	(a)
Charleston			
Huntington			
EAST NORTH CENTRAL			
Chicago	7.22	6.80	(a)
Gary			
Indianapolis			
Detroit	7.31	6.89	(a)
Flint	7.16	6.68	(b)
Akron		6.68 [3/]	
Cincinnati		6.68	(b)
Cleveland	7.31	6.68	
Steubenville			
Toledo		6.68	
Milwaukee	7.60	7.14	(a)
EAST SOUTH CENTRAL			
Birmingham	7.48	7.10	(a)
Louisville	7.60	7.22	(a)
Chattanooga		6.68	(a)
Memphis		6.55	(a)

(Continued)

Exhibit III-3 (Cont'd.)

Domestic Prices Per Barrel of Light Fuel Oil [2/]

	No. 1	No. 2	Source [2/]
WEST NORTH CENTRAL			
Davenport	$7.31	$6.85	(a)
Kansas City	7.01	6.59	(a)
Minneapolis-St. Paul	7.56	7.14	(a)
St. Louis	7.35	6.93	(a)
Omaha	7.14	6.72	(a)
WEST SOUTH CENTRAL			
New Orleans		5.59	(a)
Oklahoma City		6.22	(a)
El Paso	6.38	6.38	(a)
Houston	6.43	6.43	(a)
MOUNTAIN			
Phoenix	8.48	7.23	(a)
Denver	6.68	6.26	(a)
Salt Lake City	7.22	6.30	(a)
PACIFIC			
Los Angeles	7.27	6.64	(a)
San Francisco	7.43	6.80	(a)
Portland		6.72	(b)
Seattle	7.64	7.01	(a)
HAWAII			
Honolulu		7.14	(b)

[1/] A domestic price is the price of fuel and bought in quantities of 100 to 200 gallons.

[2/] Sources:
(a) The Oil Daily (June 4, 1968) + $0.21 ($0.005 per gallon adjustment).
(b) Survey of fuel oil dealers, March-June 1968.
No entry indicates information not obtained.

[3/] See Exhibit III-2, note 5.

EXHIBIT III-4

GEOGRAPHICAL AREAS OF THE NATIONAL SURVEY OF BURNER FUEL OILS

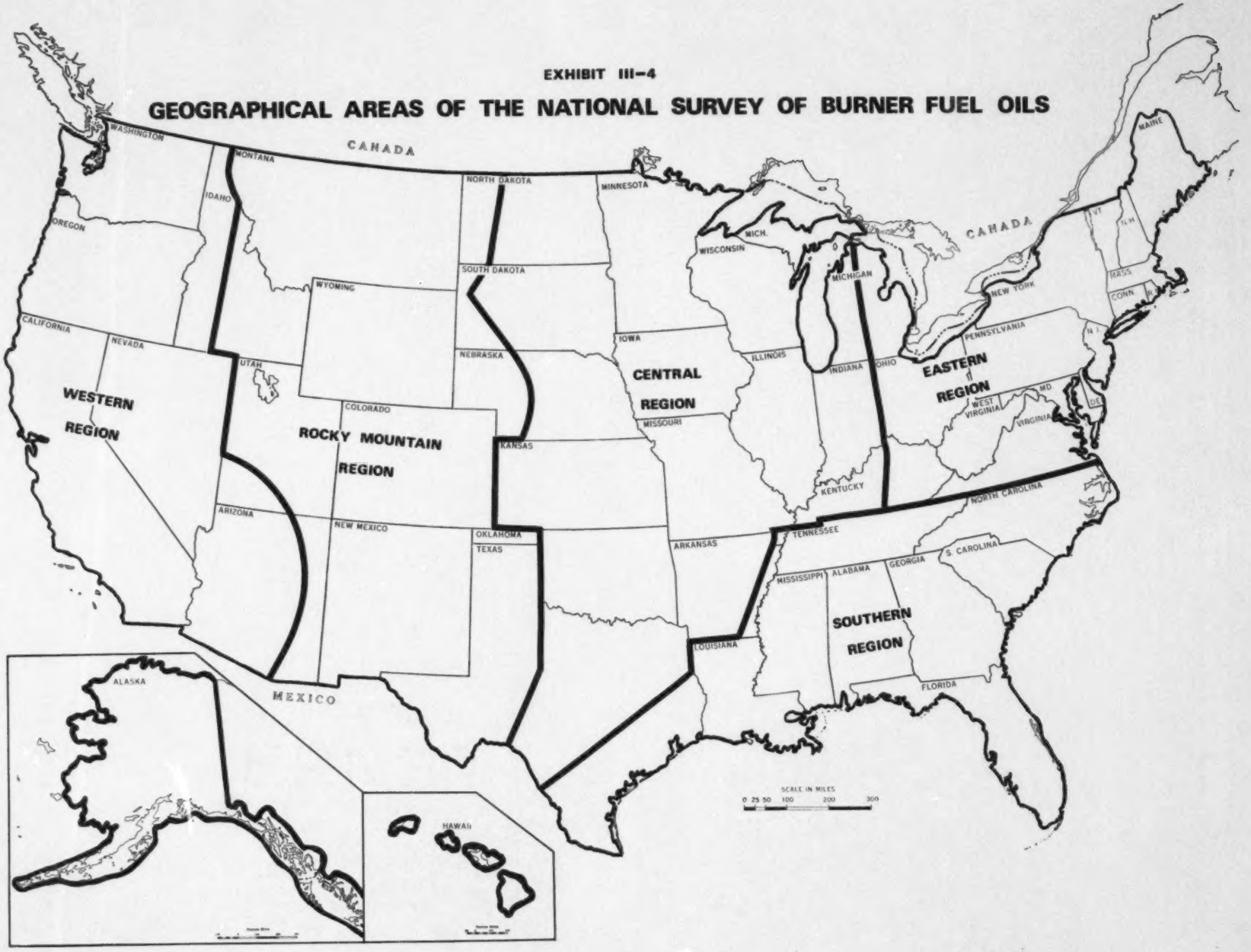

EXHIBIT III-5

SULFUR CONTENT BY WEIGHT
FOR DOMESTICALLY REFINED FUEL OIL [1/]

Fuel Grade		Eastern Region %	Southern Region %	Central Region %	Mountain Region %	Western Region %
No. 1:	Low	0.007	0.007	0.001	0.001	0.003
	Average	0.060	0.040	0.089	0.105	0.124
	High	0.24	0.105	0.37	0.41	0.45
No. 2:	Low	0.05	0.05	0.07	0.07	0.05
	Average	0.232	0.84	0.283	0.321	0.307
	High	0.49	0.34	0.50	1.50	1.50
No. 4:	Low	0.30	0.50	0.30	0.84	0.84
	Average	0.91	[2/]	0.91	1.57	1.49
	High	2.0	1.15	2.0	2.77	2.77
No. 5:	Low	0.584	1.55	0.584	1.23	0.89
	Average	0.98	[2/]	1.52	1.80	1.29
	High	2.2	3.15	3.15	2.49	1.7
No. 6:	Low	0.52	0.62	0.52	0.40	0.77
	Average	1.36	1.84	1.70	2.09	1.51
	High	2.90	3.37	4.25	4.25	4.1

Source:
[1/] O.C. Blade, Burner Fuel Oils, 1967, Petroleum Products Survey No. 51 (U.S. Department of the Interior, Bureau of Mines, August 1967) pp. 6-11.

[2/] No averages were computed, as only two samples were represented.

EXHIBIT III-6

SULFUR CONTENT BY WEIGHT FOR RESIDUAL FUEL OIL NO. 6

District/Metropolitan Area	Oil Import Administration 2/ Mean %	U.S. Public Health Service 3/			Bureau of Mines 4/			Estimated Mean 5/
		Low %	Mean %	High %	Low %	Mean %	High %	
NEW ENGLAND								
Hartford	2.33		2.38		0.52	1.36	2.90	2.33
Boston	2.28	1.55	2.14	3.30	0.52	1.36	2.90	2.28
Providence	2.42	1.55	2.26	2.46	0.52	1.36	2.90	2.42
MIDDLE ATLANTIC								
Buffalo		1.0	2.22	2.65	0.52	1.36	2.90	2.22
New York	1.77	1.0	2.32	4.4	0.52	1.36	2.90	1.77
Syracuse					0.52	1.36	2.90	1.36
Allentown	1.86	0.7	2.23	3.5	0.52	1.36	2.90	1.86 2/
Philadelphia	1.86	0.7	2.23	3.5	0.52	1.36	2.90	1.86
Pittsburgh					0.52	1.36	2.90	1.36
SOUTH ATLANTIC								
Wilmington	2.39	4.4	4.8	6.7	0.52	1.36	2.90	2.39
Washington		1.0	2.5	4.4	0.52	1.36	2.90	2.5
Jacksonville	2.07	1.93	2.45	2.7	0.62	1.84	3.37	2.07
Miami	2.28	2.2	2.46	2.6	0.62	1.84	3.37	2.28
Atlanta					0.62	1.84	3.37	1.84
Baltimore	1.98	1.0	2.65	4.4	0.52	1.36	2.90	1.98
Norfolk	2.25	1.55	2.30	2.8	0.52	1.36	2.90	2.25
Charleston					0.52	1.36	2.90	1.36
Huntington					0.52	1.36	2.90	1.36
EAST NORTH CENTRAL								
Chicago			2.70		0.52	1.70	4.25	2.70
Gary					0.52	1.70	4.25	1.70
Indianapolis					0.52	1.70	4.25	1.70
Detroit			2.70		0.52	1.36	2.90	2.70
Flint					0.52	1.36	2.90	1.36
Akron					0.52	1.36	2.90	1.36
Cincinnati					0.52	1.36	2.90	1.36

(continued)

Exhibit III-6 (Cont'd.)

Sulfur Content by Weight for Residual Fuel Oil No. 6

District/Metropolitan Area	Oil Import Administration 2/ Mean %	U.S. Public Health Service 3/			Bureau of Mines 4/			Estimated Mean 5/
		Low %	Mean %	High %	Low %	Mean %	High %	
Cleveland					0.52	1.36	2.90	1.36
Steubenville					0.52	1.36	2.90	1.36
Toledo					0.52	1.36	2.90	1.36
Milwaukee					0.52	1.70	4.25	1.70
EAST SOUTH CENTRAL								
Birmingham					0.62	1.84	3.37	1.84
Louisville					0.52	1.70	4.25	1.70
Chattanooga					0.62	1.84	3.37	1.84
Memphis					0.62	1.84	3.37	1.84
WEST NORTH CENTRAL								
Davenport					0.52	1.70	4.25	1.70
Kansas City					0.52	1.70	4.25	1.70
Minneapolis					0.52	1.70	4.25	1.70
St. Louis					0.52	1.70	4.25	1.70
Omaha					0.52	1.70	4.25	1.70
WEST SOUTH CENTRAL								
New Orleans			2.2		0.62	1.84	3.37	2.2
Oklahoma City					0.52	1.70	4.25	1.70
El Paso					0.40	2.09	4.25	2.09
Houston					0.62	1.84	3.37	1.84
MOUNTAIN								
Phoenix					0.77	1.51	4.1	1.51
Denver					0.40	2.09	4.25	2.09
Salt Lake City					0.40	2.09	4.25	2.09
PACIFIC								
Los Angeles					0.77	1.51	4.1	1.51
San Francisco			2.45		0.77	1.51	4.1	2.45
Portland					0.77	1.51	4.1	1.51
Seattle					0.77	1.51	4.1	1.51
HAWAII								
Honolulu	2.75							2.75

1/ Data were obtained from three sources. No entry indicates no information in the source.

2/ Oil Import Administration, Files of March 1968.

3/ F.A. Rohrman (U.S. Public Health Service), "Information on Imported Residual Oil - 1966," Memo. of June 15, 1967.

4/ O.C. Blade, Burner Fuel Oils, 1967, Petroleum Products Survey No. 5 (U.S. Department of the Interior, Bureau of Mines, August 1967). No entry indicates information not in the source.

5/ The estimated mean is the percentage from OIA if available; the second choice for the data is the Public Health Service memorandum, and the third is the Bureau of Mines publication.

6/ Data were reported by the Oil Import Administration and Rohrman for New Haven.

7/ Data were reported by the Oil Import Administration and Rohrman for Philadelphia.

CHAPTER IV - SURVEY OF GAS PRICES

This chapter presents price ranges of gas sold by public and municipal utilities within the boundaries of each of fifty metropolitan areas surveyed. The gas can be either natural gas, manufactured gas, or liquid propane and is usually a combination of two of these, one of which is used during peak demand to supplement the other.

Gas prices were obtained for three types of users: domestic, commercial, and industrial. A domestic price is the price for the quantity of gas used for space heating, hot water heating, cooking, etc., for a single family residence. Though the rate schedules vary in terms of definitions of "domestic quantity" from company to company, no commercial, or industrial usage would fall under these rate schedules. Residential users who do not use gas for space heating are excluded from the average prices to domestic users.

Commercial prices are prices to a user class which includes, broadly, apartment and office buildings, hotels, schools, hospitals, shopping centers, etc., heated by gas.

Industrial prices are, generally, prices to any and all large consumers of gas, except power plants. The dividing line between a commercial user and an industrial user is not always clear, but it appears that in the majority of cases two different sellers would place two buyers with the same demands in the same class. For example, most sellers of gas would classify a very large apartment building as an industrial user because of its large daily demands, even though it is a commercial establishment. The essential difference between the two classes is that the commercial user can be supplied without straining the system, while an industrial user will usually have some restriction on demand, for example, interruptible or dual fuel service, maximum

daily limits, or the stipulation that the user be located on a major gas main.

None of the data shown were independently verified by Ernst & Ernst.

SOURCES

(1) American Gas Association, Inc. A.G.A. Rate Service, I and II (New York, March 1968).

(2) Brown's Directory of North America Gas Companies, 81st Ed. (Duluth, 1967).

All data on mean prices and heat contents were drawn from Brown's Directory. The high and low of the price ranges are from the rate schedules published in the American Gas Association's Rate Service. Brown's Directory rates are those of 1966. The mean prices presented in the exhibit to this chapter, therefore, may be somewhat lower than current mean prices. The Rate Service data for the high and low of the ranges were current in March 1968.

METHODOLOGY

The gas prices presented in this chapter were obtained from published sources. High, low, and mean prices were obtained for domestic, commercial, and industrial users. In general, the mean price is the mean price as listed in Brown's Directory, and the high and low of the ranges represent one rate class above and below that mean. Where there are two or more sellers within a metropolitan area, the mean price is the weighted average of the prices in Brown's Directory, and the extremes represent the highest and lowest mean prices encountered. Where there was no mean available, the high and low represent rate classes equivalent to the price range in the nearest metropolitan area, and the mean price is the midpoint between the high and the low and is marked by an asterisk.

Finally, prices were divided by heat contents to obtain prices per million BTU. These prices appear in the exhibits to Chapter I.

FINDINGS

The compiled gas price data are presented in Exhibit IV-1. The exhibit shows prices to the three classes of users in dollars per 1,000 cubic feet or in dollars per therm (100,000 BTU). Where prices are in dollars per 1,000 cubic feet, the heat content per cubic foot is shown. The heat contents shown were used to compute the gas prices per million BTU shown in Chapter I.

Where there is no entry in the tables, either the service was not available in that city in 1966, or, if it was available, information could not be obtained.

EXHIBIT IV-1

DOMESTIC, COMMERCIAL, AND INDUSTRIAL[1/] GAS PRICES[2/]

District/Metropolitan Area	Low	Mean	High
NEW ENGLAND			
Hartford			
Domestic price per thousand cubic feet	$1.35	$1.56	$1.75
Commercial price per thousand cubic feet			
- Firm service	1.35	1.55	1.89
- Interruptible service	0.60	0.68*	0.75
Industrial price per thousand cubic feet			
- Firm service	1.20	1.43	1.54
- Interruptible service	0.45	0.54	0.60
BTU content per cubic foot	1,000	1,000	1,000
Boston			
Domestic price per thousand cubic feet	$1.50	$1.87	$2.20
Commercial price per thousand cubic feet			
- Firm service	1.70	1.75	2.20
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	1.50	1.75	1.80
- Interruptible service		0.36	
BTU content per cubic foot	1,000	1,000	1,000
Providence			
Domestic price per thousand cubic feet	$1.35	$1.93*	$2.50
Commercial price per thousand cubic feet			
- Firm service	1.25	1.88	2.50
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	1.00	1.20*	1.40
- Interruptible service			
BTU content per cubic foot	1,050	1,050	1,050
MIDDLE ATLANTIC			
Buffalo			
Domestic price per thousand cubic feet	$1.30	$1.75*	$2.20
Commercial price per thousand cubic feet			
- Firm service	0.90	1.20*	1.50
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.73	0.97*	1.20
- Interruptible service			
BTU content per cubic foot	1,000	1,000	1,000
New York			
Domestic price per thousand cubic feet	$1.38	$1.60*	$1.82
Commercial price per thousand cubic feet			
- Firm service	1.45	1.58*	1.71
- Interruptible service	0.55	0.65*	0.75
Industrial price per thousand cubic feet			
- Firm service		1.33	
- Interruptible service	0.36	0.44*	0.51
BTU content per cubic foot	1,020	1,020	1,000

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1] Gas Prices[2]

District/Metropolitan Area	Low	Mean	High[3]
Middle Atlantic, cont'd			
Syracuse			
Domestic price per thousand cubic feet	$0.88	$1.15	$1.35
Commercial price per thousand cubic feet			
- Firm service	0.95	1.09	1.20
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.90	1.02	1.20
- Interruptible service	0.67	0.68	0.69
BTU content per cubic foot	1,000	1,000	1,000
Allentown			
Domestic price per thousand cubic feet	$1.26	$1.61	$1.86
Commercial price per thousand cubic feet			
- Firm service	1.11	1.42	1.86
- Interruptible service	0.50	0.50	0.52
Industrial price per thousand cubic feet			
- Firm service	0.84	0.91	1.01
- Interruptible service	0.50	0.50	0.52
BTU content per cubic foot	1,030	1,040	1,030
Philadelphia			
Domestic price per thousand cubic feet	$1.28	$1.54	$1.78
Commercial price per thousand cubic feet			
- Firm service	1.39	1.51	1.74
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.60	1.05	N/A
- Interruptible service	0.32	0.34	0.42
BTU content per cubic foot	1,040	1,040	1,040
Pittsburgh			
Domestic price per thousand cubic feet	$0.86	$0.95	$1.24
Commercial price per thousand cubic feet			
- Firm service	0.72	0.79	0.93
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.53	0.54	0.59
- Interruptible service			
BTU content per cubic foot	1,040	1,040	1,050
SOUTH ATLANTIC			
Wilmington			
Domestic price per thousand cubic feet	$1.30	$1.50	$1.60
Commercial price per thousand cubic feet			
- Firm service	1.25	1.30	1.60
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.70	0.79	1.05
- Interruptible service	0.37	0.38	0.42
BTU content per cubic foot	1,040	1,040	1,040

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1/] Gas Prices[2/]

District/Metropolitan Area	Low	Mean	High
South Atlantic, cont'd			
Washington			
Domestic price per therm	$0.130	$0.130	$0.146
Commercial price per therm			
- Firm service	0.106	0.130	0.146
- Interruptible service	0.055	0.060	0.083
Industrial price per therm			
- Firm service			
- Interruptible service	0.055	0.060	0.083
Jacksonville			
Domestic price per therm	$0.120	$0.228	$0.250
Commercial price per therm			
- Firm service	0.100	0.129	0.130
- Interruptible service	0.038	0.040	0.042
Industrial price per therm			
- Firm service			
- Interruptible service	0.038	0.040	0.042
Miami			
Domestic price per therm	$0.275	$0.312	$0.360
Commercial price per therm			
- Firm service	0.122	0.182	0.220
- Interruptible service	0.036	0.041	0.050
Industrial price per therm			
- Firm service	0.090	0.103	0.110
- Interruptible service	0.036	0.041	0.500
Atlanta			
Domestic price per therm	$0.080	$0.090	$0.110
Commercial price per therm			
- Firm service	0.060	0.060	0.065
- Interruptible service			
Industrial price per therm			
- Firm service	0.06	0.06	0.065
- Interruptible service	0.027	0.03	0.040
Baltimore			
Domestic price per thousand cubic feet	$1.23	$1.40	$1.86
Commercial price per thousand cubic feet			
- Firm service	1.35	1.58	1.86
- Interruptible	0.56	0.56*	0.56
Industrial price per thousand cubic feet			
- Firm service	0.82	0.86	1.02
- Interruptible service	0.49	0.51	0.56
BTU content per cubic foot	1,030	1,030	1,030
Norfolk			
Domestic price per thousand cubic feet	$1.35	$1.67	$2.05
Commercial price per thousand cubic feet			
- Firm service	1.12	1.14	1.26
- Interruptible service	0.44	0.46	0.59
Industrial price per thousand cubic feet			
- Firm service	0.75	0.81	0.85
- Interruptible service	0.44	0.46	0.49
BTU content per cubic foot	1,000	1,030	1,000

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1] Gas Prices[2]

District/Metropolitan Area	Low	Mean	High
South Atlantic, cont'd			
Charleston			
Domestic price per thousand cubic feet	$0.72	$0.86	$2.55
Commercial price per thousand cubic feet			
- Firm service	0.70	0.71	0.72
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.59	0.67	0.68
- Interruptible service		0.43	
BTU content per cubic foot	1,032	1,032	1,032
Huntington			
Domestic price per thousand cubic feet	$0.81	$0.91	$2.30
Commercial price per thousand cubic feet			
- Firm service	0.68	0.75	0.81
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service			
- Interruptible service		0.45	
BTU content per cubic foot	1,142	1,119	1,142
EAST NORTH CENTRAL			
Chicago			
Domestic price per therm	$0.093	$0.106	$0.115
Commercial price per therm			
- Firm service	0.069	0.089	0.090
- Interruptible service			
Industrial price per therm			
- Firm service	0.052	0.056	0.059
- Interruptible service	0.026	0.028	0.030
Gary			
Domestic price per thousand cubic feet	$0.85	$1.03	$1.05
Commercial price per thousand cubic feet			
- Firm service	0.90	0.97	1.00
- Interruptible service	0.50	0.55*	0.60
Industrial price per thousand cubic feet			
- Firm service	0.30	0.45	0.50
- Interruptible service		0.30	
BTU content per cubic foot	1,040	1,040	1,040
Indianapolis			
Domestic price per thousand cubic feet	$0.72	$0.82	$1.00
Commercial price per thousand cubic feet			
- Firm service	0.62	0.73	0.79
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.360	0.54	0.62
- Interruptible service	0.345	0.36	0.405
BTU content per cubic foot	900	900	900

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1/] Gas Prices[2/]

District/Metropolitan Area	Low	Mean	High
East North Central, cont'd			
Detroit			
Domestic price per thousand cubic feet	$0.81	$0.90	$0.96
Commercial price per thousand cubic feet			
- Firm service	0.81	0.84	0.96
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.50	0.57	0.66
- Interruptible service	0.42	0.44	0.47
BTU content per cubic foot	1,000	1,031	1,000
Flint			
Domestic price per thousand cubic feet	$0.95	$1.21*	$1.47
Commercial price per thousand cubic feet			
- Firm service	0.77	0.91*	1.05
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.52	0.57*	0.61
- Interruptible service			
BTU content per cubic foot	1,000	1,000	1,000
Akron			
No rates published. Akron is served by the East Ohio Gas Co. See the Cleveland rates for examples.			
Cincinnati			
Domestic price per thousand cubic feet	$0.72	$0.76*	$0.80
Commercial price per thousand cubic feet			
- Firm service	0.67	0.71*	0.75
- Interruptible service			
Industrial price			
- Firm service			
- Interruptible service			
BTU content per cubic foot	1,050	1,050	1,050
Cleveland			
Domestic price per thousand cubic feet	$0.76	$0.84	$1.75
Commercial price per thousand cubic feet			
- Firm service	0.67	0.73	0.76
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.53	0.56	0.59
- Interruptible service			
BTU content per cubic foot	1,040	1,040	1,040
Steubenville			
Domestic price per thousand cubic feet	$0.77	$0.88	$3.01
Commercial price per thousand cubic feet			
- Firm service	0.77	0.80	3.01
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service		0.49	
- Interruptible service			
BTU content per cubic foot	1,030	1,030	1,030

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1/] Gas Prices[2/]

District/Metropolitan Area	Low	Mean	High
East North Central, cont'd			
Toledo - No rates published			
Milwaukee			
Domestic price per therm	$0.105	$0.117	$0.140
Commercial price per therm			
- Firm service	0.075	0.108	0.116
- Interruptible service			
Industrial price per therm			
- Firm service	0.075	0.087	0.105
- Interruptible service	0.045	0.049	0.065
EAST SOUTH CENTRAL			
Birmingham			
Domestic price per thousand cubic feet	$0.92	$1.12	$1.40
Commercial price per thousand cubic feet			
- Firm service	0.43	0.54*	0.65
- Interruptible service	0.31	0.43*	0.55
Industrial price per thousand cubic feet			
- Firm service	0.30	0.35*	0.40
- Interruptible service	0.30	0.31*	0.32
BTU content per cubic foot	1,000	1,000	1,000
Louisville			
Domestic price per thousand cubic feet	$0.70	$0.73	$0.75
Commercial price per thousand cubic feet			
- Firm service	0.60	0.62	0.65
- Interruptible service	0.50	0.53*	0.56
Industrial price per thousand cubic feet			
- Firm service		0.45	
- Interruptible service	0.44	0.47*	0.50
BTU content per cubic foot	1,030	1,030	1,030
Chattanooga			
Domestic price per thousand cubic feet	$1.25	$1.31	$1.35
Commercial price per thousand cubic feet			
- Firm service	1.00	1.02	1.10
- Interruptible service	0.38	0.44*	0.50
Industrial price per thousand cubic feet			
- Firm service	0.40	0.64	0.70
- Interruptible service	0.35	0.37	0.38
BTU content per cubic foot	1,000	1,000	1,000
Memphis			
Domestic price per thousand cubic feet	$0.69	$0.80	$1.16
Commercial price per thousand cubic feet			
- Firm service		0.50	
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.30	0.33	0.44
- Interruptible service	0.22	0.23	0.30
BTU content per cubic foot	1,000	1,000	1,000

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1] Gas Prices[2]

District/Metropolitan Area	Low	Mean	High
WEST NORTH CENTRAL			
Davenport			
Domestic price per thousand cubic feet	$0.63	$0.79	$1.20
Commercial price per thousand cubic feet			
- Firm service	0.63	0.70	1.20
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.49	0.57	0.80
- Interruptible service	0.27	0.28	0.29
BTU content per cubic foot	1,030	1,058	1,030
Kansas City			
Domestic price per thousand cubic feet	$0.50	$0.59	$0.66
Commercial price per thousand cubic feet			
- Firm service	0.50	0.58*	0.66
- Interruptible service	0.37	0.44*	0.51
Industrial price per thousand cubic feet			
- Firm service			
- Interruptible service	0.22	0.24	0.35
BTU content per cubic foot	1,000	1,000	1,000
Minneapolis			
Domestic price per thousand cubic feet	$0.91	$1.02	$1.07
Commercial price per thousand cubic feet			
- Firm service	0.77	0.85*	0.93
- Interruptible service	0.40	0.49*	0.57
Industrial price per thousand cubic feet			
- Firm service	0.68	0.75*	0.82
- Interruptible service	0.35	0.37	0.40
BTU content per cubic foot	1,000	1,000	1,000
St. Louis			
Domestic price per therm	$0.075	$0.101	$0.118
Commercial price per therm			
- Firm service	0.066	0.083	0.097
- Interruptible service			
Industrial price per therm			
- Firm service	0.033	0.055	0.058
- Interruptible service	0.028	0.033	0.037
Omaha			
Domestic price per thousand cubic feet	$0.65	$0.72	$0.87
Commercial price per thousand cubic feet			
- Firm service	0.57	0.60	0.65
- Interruptible service	0.41	0.47*	0.52
Industrial price per thousand cubic feet			
- Firm service		0.48	
- Interruptible service	0.275	0.28	0.295
BTU content per cubic foot	1,000	1,000	1,000

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1/] Gas Prices[2/]

District/Metropolitan Area	Low	Mean	High
WEST SOUTH CENTRAL			
New Orleans			
Domestic price per thousand cubic feet	$0.60	$0.76	$0.90
Commercial price per thousand cubic feet			
- Firm service		0.44	0.50
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.12	0.25	0.50
- Interruptible service			
BTU content per cubic foot	1,080	1,111	1,080
Oklahoma City - No rates published.			
El Paso			
Domestic price per thousand cubic feet	$0.76	$0.81*	$0.86
Commercial price per thousand cubic feet			
- Firm service	0.34	0.49*	0.64
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.34	0.49*	0.64
- Interruptible service			
BTU content per cubic foot	1,117	1,117	1,117
Houston			
Domestic price per thousand cubic feet	$0.90	$0.95	$0.97
Commercial price per thousand cubic feet			
- Firm service	0.45	0.50	0.65
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service		0.26	
- Interruptible service			
BTU content per cubic foot	1,000	1,000	1,000
MOUNTAIN			
Phoenix			
Domestic price per therm	$0.092	$0.108	$0.139
Commercial price per therm			
- Firm service	0.056	0.062	0.080
- Interruptible service			
Industrial price per therm			
- Firm service	0.041	0.049	0.056
- Interruptible service			
Denver			
Domestic price per thousand cubic feet	$0.44	$0.57	$1.05
Commercial price per thousand cubic feet			
- Firm service	0.44	0.47	0.57
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.19	0.24*	0.29
- Interruptible service			
BTU content per cubic foot	1,000	1,000	1,000

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1/] Gas Prices[2/]

District/Metropolitan Area	Low	Mean	High
Mountain, cont'd			
Salt Lake City			
Domestic price per thousand cubic feet	$0.52	$0.58	$0.76
Commercial price per thousand cubic feet			
- Firm service	0.42	0.54	0.76
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.31	0.34	0.36
- Interruptible service	0.22	0.24	0.26
BTU content per cubic foot	875	918	875
PACIFIC			
Los Angeles			
Domestic price per thousand cubic feet	$0.97	$1.01	$1.11
Commercial price per thousand cubic feet			
- Firm service	0.50	0.65	0.74
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.57	0.59	0.60
- Interruptible service	0.34	0.35	0.53
BTU content per cubic foot	1,075	1,084	1,075
San Francisco			
Domestic price per thousand cubic feet	$0.65	$0.81	$1.22
Commercial price per thousand cubic feet			
- Firm service	0.62	0.66	1.22
- Interruptible service			
Industrial price per thousand cubic feet			
- Firm service	0.57	0.58	0.61
- Interruptible service	0.35	0.40	0.45
BTU content per cubic foot	1,050	1,050	1,050
Portland			
Domestic price per therm	$0.100	$0.152	$0.170
Commercial price per therm			
- Firm service	0.120	0.143	0.170
- Interruptible service			
Industrial price per therm			
- Firm service	0.060	0.062	0.080
- Interruptible service	0.032	0.036	0.038
Seattle			
Domestic price per therm	$0.117	$0.13	$0.134
Commercial price per therm			
- Firm service	0.124	0.13	0.144
- Interruptible service			
Industrial price per therm			
- Firm service	0.094	0.10	0.114
- Interruptible service	0.033	0.035	0.037

Exhibit IV-1, cont'd

Domestic, Commercial, and Industrial[1/] Gas Prices[2/]

District/Metropolitan Area	Low	Mean	High
HAWAII			
Honolulu			
Domestic price per therm	4/		
Commercial price per therm			
- Firm service	$0.302	$0.31	$0.332
- Interruptible service			
Industrial price per therm			
- Firm service	0.197	0.210	0.217
- Interruptible service			

☆ Mean price is the mid-point between the high and the low.

1/ A domestic price is the price of gas bought in the quantity needed for space heating, hot water heating, cooking, etc., for a single family residence. A commercial price is the price to a user class which includes, broadly, apartment and office buildings, hotels, schools, hospitals, etc., heated by gas. An industrial price is a price to large consumers of gas, except power plants.

2/ Average prices and BTU content were drawn from Brown's Directory of North American Gas Companies, 81st ed. (Duluth, 1967). The average prices are 1966 prices. The data for the high and low of the range are from A.G.A. Rate Service, vols. I and II, American Gas Association (New York, March 1968). These high and low prices were current in March 1968. No entry indicates data not obtained.

3/ The difference between high and average represents prompt payment discount.

4/ Natural gas is not used for space heating.

CHAPTER V - SURVEY OF POWER PLANT FUEL PRICES

This chapter presents prices of coal, fuel oil, and natural gas to power plants. This class of fuel user is comprised, broadly, of steam electric generating stations operated by a public or municipal utility. It includes plants of all sizes that supply electricity to the public and plants whose main customer is an industrial plant supplied with electricity or a refinery supplied with process steam.

Power plant fuel prices were sought for fifty metropolitan areas. Price and heat content data were obtained for 1966. None of the data were independently verified by Ernst & Ernst.

METHODOLOGY

Prices, sulfur contents, and heat contents were obtained from published sources. For each type of fuel high, low, and mean prices were sought. Where information was obtained for only one plant in an area burning a type of fuel, the figures were taken as mean. Where there was more than one source of data, the highest and lowest figures encountered in the sample were taken as the high and low, and a weighted average was computed.

Prices were divided by heat contents to obtain prices per million BTU, which are shown in the summary exhibits of Chapter I.

SOURCES

(1) DeCarlo, Joseph A., et. al., Sulfur Content of United States Coal, Information Circular 8312, (Bureau of Mines, U. S. Department of the Interior, 1966).

(2) Rohrman, F. A. (U. S. Public Health Service) "Information on Imported Residual Oil - 1966," Memo of 15 June 1967.

(3) Natural Coal Association, Steam-Electric Plant Factors - 1966, (Washington, D. C., 1967).

All data presented in this section on fuel usage, price, and heat content were drawn from Steam-Electric Plant Factors - 1966. Sulfur contents of coal are from DeCarlo and are based on analysis of minemouth samples on a dry basis. The ranges presented (DeCarlo pp. 36-44) represent the statewide range and average of sulfur content of bituminous coal shipped to electric utilities in 1964. It is assumed that sulfur contents have not changed significantly since then. Sulfur contents of residual oil were computed from Rohrman's memorandum on sulfur contents of imported residual oil in various cities in the United States. The sulfur contents of the lighter fuel oils were obtained in confidence from a major refiner.

FINDINGS

Exhibits V-1, V-2, and V-3 present the prices, sulfur contents, and heat contents for coal, fuel oil, and natural gas, respectively, used by power plants in the surveyed cities.

Coal data are for all coal used, as reported by the power plants, and exclude data on coke. Light fuel oils are nos. 1 and 2; they include range oil, diesel oil, kerosene, and burner oils. Heavy fuel oils are nos. 4, 5, and 6; petroleum coke is excluded. Natural gas includes natural, manufactured, and refinery gas.

EXHIBIT V-1

COAL PRICES FOR POWER PLANTS[1/]

District/Metropolitan Area	Price per Ton[2/]			Mean Heat Contents[2/] (000's BTU per Ton)	Sulfur Content by Weight[3/]		
	Low	Mean	High		Low %	Mean %	High %
NEW ENGLAND							
Hartford	$8.32	$8.70	$9.30	26,769	0.7	2.0	3.6
Boston	9.48	9.50	9.67	26,912	0.5	1.2	3.6
Providence	8.96	8.96	8.96	27,317	0.5	1.6	3.6
MIDDLE ATLANTIC							
Buffalo		7.36		26,884		1.9	
New York	7.49	8.43	8.95	26,847	0.5	1.9	3.6
Syracuse	No power plants in the area						
Allentown		6.81		26,302	0.5	1.9	4.1
Philadelphia	7.78	7.83	7.84	27,000	0.5	1.9	4.1
Pittsburgh	4.25	4.35	4.63	23,901	0.5	1.9	4.1
SOUTH ATLANTIC							
Wilmington		7.32		26,142	0.5	1.8	3.6
Washington	6.80	7.21	8.98	26,029	0.5	1.8	3.5
Jacksonville							
Miami							
Atlanta	6.35	6.35	6.35	24,578	0.5	1.9	4.0
Baltimore	7.69	7.69	7.69	26,982	0.5	1.8	3.5
Norfolk	7.61	7.70	9.46	26,644	0.5	1.0	3.1
Charleston		4.65		26,460	0.6	2.5	5.0
Huntington	4.07	4.40	4.49	23,158	0.5	2.6	5.0
EAST NORTH CENTRAL							
Chicago	5.49	5.53	5.85	20,331	0.5	2.8	4.5
Gary		5.62		22,588	0.6	3.1	5.3
Indianapolis	5.01	5.23	5.47	22,739	0.6	3.1	5.3
Detroit	6.64	6.93	7.91	24,574	0.5	2.1	4.5
Flint	No power plants in the area						
Akron		4.88		22,934	0.5	3.2	5.0
Cincinnati	4.39	4.89	5.84	23,738	0.5	3.2	5.0
Cleveland[4/]	5.81	5.92	6.01	33,968	0.5	3.2	5.0
Steubenville	4.21	4.35	4.41	23,514	0.5	3.2	5.0
Toledo	6.61	6.63	6.68	24,286	0.5	3.2	5.0
Milwaukee	6.94	7.00	8.93	23,891	0.6	2.4	4.5
EAST SOUTH CENTRAL							
Birmingham		6.24		23,544	0.7	1.9	4.0
Louisville	4.23	4.24	4.31	22,674	0.5	2.6	4.1
Chattanooga	No power plants in the area. Electricty purchased from TVA.						
Memphis		4.74		24,088	0.5	2.4	4.3

Exhibit V-1, cont'd

Coal Prices For Power Plants[1/]

District/Metropolitan Area	Price per Ton[2/] Low	Mean	High	Mean Heat Contents[2/] (000's BTU per Ton)	Sulfur Content by Weight[3/] Low %	Mean %	High %
WEST NORTH CENTRAL							
Davenport	$	$5.49	$	21,292	0.5	2.8	4.5
Kansas City	5.65	6.06	7.06	22,955	0.6	3.3	6.0
Minneapolis	6.10	6.23	6.48	23,074	0.7	2.5	4.1
St. Louis	4.20	4.45	5.06	22,475	1.1	3.5	6.0
Omaha	6.46	6.89	7.08	23,841	0.6	3.0	6.0
WEST SOUTH CENTRAL							
New Orleans							
Oklahoma City							
El Paso							
Houston							
MOUNTAIN							
Phoenix							
Denver	4.57	4.85	5.05	21,272	0.3	0.6	0.9
Salt Lake City		6.65		24,600	0.6	0.7	0.8
PACIFIC							
Los Angeles							
San Francisco							
Portland							
Seattle							
HAWAII							
Honolulu							

1/ Power plants include, broadly, steam electric generating stations operated by a public or municipal utility, plants that supply electricity to the public, and plants whose main customer is an industrial plant supplied with electricity or a refining supplied with process steam. No entry indicates information not available, either because cost was not used by power plants in the area in 1966 or because prices were privately negotiated and not published. Where only a mean is given, information was obtained for only one power plant.

2/ National Coal Association, Steam Electric Plant Factors - 1966, (Washington, D. C., 1967). The high and low prices are the highest and lowest encountered in the sample. The mean price and mean heat content are weighted averages.

3/ Joseph A. DeCarlo, et. al., Sulfur Content of United States Coal, Information Circular 8312 (Bureau of Mines, U. S. Department of the Interior, 1966). The high, low, and mean sulfur contents are the high, low, and weighted average for coal burned by power plants within a state. Sulfur content data were not correlated with prices.

4/ Fuel prices for plants operated by the Cleveland Department of Public Utilities were not available.

EXHIBIT V-2

FUEL OIL PRICES FOR POWER PLANTS[1/]

District/Metropolitan Area	Heavy Grades: Price per Barrel[2/] Low	Mean	High	Mean Heat Content[2/] (000's BTU per Barrel)	Sulfur Content by Weight[3/4/] Low %	Mean %	High %	Light Grades: Price per Barrel[2/] Low	Mean	High	Mean Heat Content[2/] (000's BTU per Barrel)	Sulfur Content by Weight[4,5/] Low %	Mean %	High %
NEW ENGLAND														
Hartford	$2.05	$2.11	$2.12	6,279	2.2	2.4	2.5	$	$	$				
Boston	1.96	1.97	1.98	6,273	1.6	2.2	3.5							
Providence	2.07	2.08	2.25	6,246	1.6	2.3	2.5							
MIDDLE ATLANTIC														
Buffalo														
New York	1.85	1.99	2.41	6,257	1.0	2.3	4.4		4.12		5,743		0.25	
Syracuse	No power plants in the area				No power plants in the area									
Allentown									3.98		5,784	0.10	0.25	0.30
Philadelphia	1.92	2.00	3.49	6,369	0.7	2.2	3.5		4.78		5,766		0.829	
Pittsburgh								4.39	4.49	5.31	5,613	0.10	0.25	0.30
SOUTH ATLANTIC														
Wilmington	2.05	2.51	2.73	6,244	4.4	4.8	6.7							
Washington				6,300	1.0	2.5	4.4							
Jacksonville	2.08	2.08	2.22	6,209	1.9	2.5	2.7							
Miami	2.06	2.06	2.38	6,300	2.2	2.5	2.6							
Atlanta								4.23	4.23	4.23	5,712	0.10	0.25	0.30
Baltimore	2.65	2.65	2.65	6,221	1.0	2.7	4.4							
Norfolk														
Charleston											5,880	0.10	0.25	0.30
Huntington								3.89	4.08	4.11	5,779	0.10	0.25	0.30
EAST NORTH CENTRAL														
Chicago														
Gary														
Indianapolis														
Detroit														
Flint	No power plants in the area													
Akron														
Cincinnati														
Cleveland[6/]														
Steubenville									3.91		5,813	0.10	0.25	0.30
Toledo									3.93		5,787	0.10	0.25	0.30
Milwaukee									3.91		5,666	0.03	0.05	0.08
EAST SOUTH CENTRAL														
Birmingham	A small volume of heavy grade burned; no data available													
Louisville														
Chattanooga	No power plants in the area													
Memphis														

Exhibit V-2, cont'd

Fuel Oil Prices For Power Plants[1/]

District/Metropolitan Area	Heavy Grades: Price per Barrel[2/] Low	Mean	High	Mean Heat Content[2/] (000's BTU per Barrel)	Sulfur Content by Weight[3/4/] Low %	Mean %	High %	Light Grades: Price per Barrel[2/] Low	Mean	High	Mean Heat Content[2/] (000's BTU per Barrel)	Sulfur Content by Weight[4/5/] Low %	Mean %	High %
WEST NORTH CENTRAL														
Davenport	$	$	$					$	$	$				
Kansas City								3.94	4.38	5.01	5,637	0.12	0.17	0.20
Minneapolis[7/]														
St. Louis												0.40	0.45	0.50
Omaha	2.88	3.00	3.77	6,397										
WEST SOUTH CENTRAL														
New Orleans[7/]		2.96		6,280		2.2								
Oklahoma City														
El Paso	2.42	2.42	2.42	6,471										
Houston[8/]	1.95	2.06	2.16											
MOUNTAIN														
Phoenix														
Denver		2.47		6,216										
Salt Lake City	1.60	1.60	1.60	6,478		1.0								
PACIFIC														
Los Angeles	1.85	1.98	2.29	6,408										
San Francisco	Approximately 250,000 barrels heavy grade buried; no data obtained													
Portland	No fuel oil data obtained													
Seattle	Approximately 2,000 barrels heavy grade buried; no data obtained													
HAWAII														
Honolulu	No fuel oil data obtained													

1/ Power plants include, broadly, steam electric generating status operated by a public or municipal utility, plants that supply electricity to the public, and plants whose main customer is an industrial plant supplied with electricity or a refining supplied with process steam. No entry indicates information not available, either because fuel oil was not used by power plants in the area in 1966 or because prices were privately negotiated and not published. Where only a mean is given, information was obtained for only one power plant using fuel oil.

2/ National Coal Association, Steam Electric Plant Factors - 1966 (Washington, D. C., 1967). The high and low prices are the highest and lowest encountered in the sample. The mean price and mean heat content are weighted averages.

3/ F. A. Rohrman (U. S. Public Health Service), "Information on Imported Residual Oil - 1966," Memo of June 15, 1967.

4/ The high, low, and mean sulfur contents are the high, low, and weighted average by area. They were not correlated with prices.

5/ Private communication with major refiner.

6/ Fuel prices for plants operated by the Cleveland Department of Public Utilities were not available.

7/ Data represent small amount of fuel oil used for start-up only.

8/ 200 barrels burned; no other data available.

EXHIBIT V-3

GAS PRICES FOR POWER PLANTS [1/2/]

District/Metropolitan Area	Interruptible Service				Firm Service			
	Price per 1,000 Cubic Feet			Mean Heat Content	Price per 1,000 Cubic Feet			Mean Heat Content
	Low	Mean	High	(1,000 BTU per 1,000 Cubic Feet)	Low	Mean	High	(1,000 BTU per 1,000 Cubic Feet)
NEW ENGLAND								
Hartford	$	$0.337	$	1,040	$	$	$	
Boston		0.312		1,000				
Providence		0.380		1,046				
MIDDLE ATLANTIC								
Buffalo								
New York				1,039				
Syracuse	No power plants in the area							
Allentown								
Philadelphia								
Pittsburgh								
SOUTH ATLANTIC								
Wilmington	0.109 [3/]	0.141	0.279	1,044				
Washington								
Jacksonville								
Miami	0.340	0.340	0.340	1,000				
Atlanta								
Baltimore		0.42		1,025				
Norfolk								
Charleston								
Huntington								
EAST NORTH CENTRAL								
Chicago	0.249	0.252	0.255	1,037				
Gary		0.257		1,000				
Indianapolis								
Detroit								
Flint	No power plants in the area							
Akron								
Cincinnati								
Cleveland [4/]								
Steubenville								
Toledo [5/]		0.150		563				
Milwaukee		0.358		1,024				
EAST SOUTH CENTRAL								
Birmingham								
Louisville	0.224	0.224	0.224	1,035				
Chattanooga	No power plant in the area							
Memphis		0.215		1,050				

Exhibit V-3, cont'd

Gas Prices For Power Plants[1/2/]

District/Metropolitan Area	Interruptible Service				Firm Service			
	Price per 1,000 Cubic Feet			Mean Heat Content	Price per 1,000 Cubic Feet			Mean Heat Content
	Low	Mean	High	(1,000 BTU per 1,000 Cubic Feet)	Low	Mean	High	(1,000 BTU per 1,000 Cubic Feet
WEST NORTH CENTRAL								
Davenport	$	$0.291	$	1,058	$	$	$	
Kansas City				1,004				
Minneapolis	0.236	0.241	0.261	1,004				
St. Louis	0.221	0.222	0.224	1,042				
Omaha	0.248	0.254	0.270	1,008				
WEST SOUTH CENTRAL								
New Orleans					0.206	0.210	0.211	1,088
Oklahoma City					0.174	0.174	0.234	1,042
El Paso					0.294	0.294	0.294	1,073
Houston					0.206	0.207	0.209	1,051
MOUTAIN								
Phoenix					0.324	0.324	0.324	1,087
Denver	0.183	0.186	0.217	842				
Salt Lake City	0.245	0.245	0.248	932				
PACIFIC								
Los Angeles[6/]	0.312	0.330	0.333	1,082				
San Francisco[6/]	0.336	0.352	0.386	1,066				
Portland		0.385		1,069				
Seattle								
HAWAII								
Honolulu								

1/ Power plants include, broadly, steam electric generating stations operated by a public or municipal utility, plants that supply electricity to the public, and plants whose main customer is an industrial plant supplied with electricity or a refinery supplied with process steam. No entry indicates information not available, either because natural gas was not used by power plants in the area in 1966 or because prices were privately negotiated and not published. Where only a mean price is given, information was obtained for only one power plant using gas.

2/ National Coal Association, Steam Electric Plant Factors - 1966 (Washington, D. C., 1967). The high and low prices are the highest and lowest encountered in the sample. The mean price and mean heat content are weighted averages.

3/ Price for refining gas, not natural gas.

4/ Fuel prices for plants operated by the Cleveland Department of Public Utilities were not available.

5/ Manufactured gas.

6/ Cost data showed no price difference between firm and interruptible service.

CHAPTER VI - COSTS OF FUEL SUBSTITUTION AND FUEL SWITCHING

This chapter presents a methodology to calculate the order-of-magnitude costs of reducing sulfur oxide and particulate emissions by changing fuels in a specific stationary combustion source. Two types of fuel changes are considered: fuel substitution and fuel switching. Fuel substitution is defined as the replacement of the present fuel with another of the same type, for example, high sulfur coal replaced by low sulfur coal. Fuel switching is defined as the replacement of the present fuel with a fuel of another type, for example, coal replaced by low sulfur fuel oil or by natural gas. The methodology presented gives an order-of-magnitude estimate, not an engineered cost estimate, for a given installation.

COST ELEMENTS

The total cost of replacing one fuel with another is made up of the following elements:

(1) The difference between the present fuel cost and the cost of the replacement fuel required to yield the same net input for the installation.

(2) The cost of boiler conversion where fuel switching is applied. This cost element includes all burners, valves, instruments, storage tanks, etc., plus the installation costs of these items.

(3) The cost differential for operating and maintenance expenses between the two boiler units. This element includes operating personnel, ash removal, and a system of preventive maintenance.

The cost data presented in this chapter are based on the following assumptions:

(1) Present fuel cost is the cost of the present fuel delivered to the storage facilities of the installation.

(2) Costs of replacement fuel are of two distinct classes:

a. Costs of fuels in common use today

b. Costs of low sulfur coal and low sulfur heavy fuel oils.

Chapters II through IV show costs per ton, barrel, or 1,000 cubic feet, and Chapter I shows costs per million BTU for coal, fuel oil, and natural gas.

Desulfurized heavy fuel oils, grade nos. 4, 5, and 6, will also demand a higher price. The additional cost per barrel and per million BTU[1/] to reach certain maximum sulfur

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1/The cost per million BTU is computed using the BTU content of the "no-sulfur-guarantee" fuel oil. The Bechtel Corporation, in a report entitled Desulfurization Costs, Residual Fuel Oil, Typical Caribbean Refinery, Venezuelan Crude Oil, February 1967, noted that during the desulfurization process, the volumetric heating value of the fuel oil tends to decrease; thus, additional fuel oil on a volume basis is required to provide the same total heat. Bechtel used a figure of six percent additional fuel oil by volume where Venezuelan crude oil is reduced to approximately 0.5 percent sulfur content by weight. (Example: if a barrel of no sulfur guarantee no. 6 costs $2.30 per barrel and the cost of desulfurization is $0.80 per barrel, the cost per barrel is $3.10, but the cost per equivalent heat content per barrel is $3.10 x 1.06=$3.29). However, for the calculation using cost per million BTU in this chapter no adjusting factor is used because of the present lack of knowledge of the exact factors for various levels of desulfurization of different crude oils.

levels as presented in Exhibit VI-1 should be added to the cost for no-sulfur guarantee fuel oil presented in Chapters I and III of this report, if no low sulfur fuel oil prices are present. The costs presented in Exhibit VI-1 are based on The Economics of Residual Fuel Oil Desulfurization, (Bechtel Corporation, June 1964) and other sources.

(3) Boiler conversion is assumed to be a typical one for that type of installation without boiler replacement. The costs are annualized using the following assumptions:

a. The depreciation periods assumed for the three classes of users are:

Power Plants	- 40 years
Industrial	- 25 years
Commercial	- 15 years

b. The straight line method of depreciation is used.

c. An amount equal to the annual depreciation is included to cover certain taxes, insurance, interest, and miscellaneous charges.

(4) Boiler operating and maintenance costs - The difference between the costs incurred with the present unit and those for the planned unit are credited to the annualized boiler conversion costs to arrive at the increased annual cost of the installation after fuel switching. These costs are presented in Exhibit VI-2 totalled with the annualized cost of boiler conversion.

EXHIBIT VI-1

ESTIMATES OF ADDED COST FOR DESULFURIZED FUEL OILS[1/]

Fuel Oil Grade	Resulting Sulfur Content By Weight	Additional Cost Per Barrel[2/]	Additional Cost Per Million BTU[3/]
No. 6 - East and Gulf Coast[4/]	1.0%	$0.40	$0.06
	0.5	0.80	0.13
Inland and Pacific Coast[5/]	1.0	0.20	0.03
	0.5	0.65	0.10
No. 5 - East and Gulf Coast	1.0	0.32	0.05
	0.5	0.64	0.10
Inland and Pacific Coast	1.0	0.16	0.03
	0.5	0.52	0.08
No. 4 - East and Gulf Coast	0.5	0.48	0.08
Inland and Pacific Coast	0.5	0.39	0.06

1/ The costs presented here were selected after review of The Economics of Fuel Oil Desulfurization (Bechtel Corporation, June, 1964) and other sources. These costs may be added to the prices in Chapter I or Chapter III for no sulfur maximum guaranteed fuel oil. No adjustment in price has been made for loss of heat content through the desulfurization process.

2/ A barrel of fuel oil is equal to 42 gallons.

3/ See Exhibit VI-5 for BTU contents of the various grades of fuel oil.

4/ The East and Gulf Coast regions include the following cities:

Hartford	Allentown	New Orleans
Boston	Philadelphia	Miami
Providence	Baltimore	Jacksonville
New York	Norfolk	Wilmington
		Washington

5/ The Inland and Pacific region includes all other metropolitan areas included in Exhibit I-1 of this report.

EXHIBIT VI-2

ANNUAL COSTS FOR BOILER CONVERSION AND ADDITIONAL ANNUAL COSTS FOR OPERATION AND MAINTENANCE 1/

Type of Conversion	CLASS OF USER		
	Power Plants	Industrial	Commercial
Coal to heavy oil	$10,500	$4,000	$2,000
Coal to gas	4,000	3,400	700
Coal to gas and light fuel oil on an interruptible basis	9,500	4,000	1,700
Heavy fuel oil to gas and fuel oil on an interruptible basis	2,750	2,400	900
Heavy fuel oil to gas	1,800	1,200	850

1/ The typical annual costs presented here reflect different periods of depreciation on the capital costs of boiler conversion. The depreciation periods used are: power plant - 40 years, industrial - 25 years, and commercial - 15 years. The straight line method of depreciation is used. An amount equal to the annual depreciation is included to cover certain taxes, insurance, interest, and miscellaneous charges. These costs were obtained through conversation with engineers employed by major boiler conversion companies.

USER MODELS

Three sizes of boilers are given as examples to demonstrate the calculation of the cost and effectiveness of fuel substitution and fuel switching. The models for power plants, industrial users, and commercial users each represent a typical boiler size that could be found in most of the cities included in the fuel survey. The installation could be made up of two or more of these units; however, the cost of only one unit is presented here. The model boilers for the three users are shown in Exhibit VI-3.

EXHIBIT VI-3

CHARACTERISTICS OF BOILERS IN THE
POWER PLANT, INDUSTRIAL, AND COMMERCIAL MODELS

POWER PLANT BOILER	
Horsepower 1/	4,500 hp.
Pounds of steam produced per hour 2/	155,000 lbs.
Fuel consumption per hour	200,000,000 BTU
INDUSTRIAL BOILER	
Horsepower	1,700 hp.
Pounds of steam produced per hour 2/	60,000 lbs.
Fuel consumption per hour	75,000,000 BTU
COMMERCIAL BOILER	
Horsepower 1/	200 hp.
Pounds of steam produced per hour 2/	7,000 lbs.
Fuel consumption per hour	9,000,000 BTU

1/ One boiler horsepower equals 33,475 BTU per hour heat to steam or 44,633 BTU per hour input for 75 percent overall boiler efficiency.

2/ One boiler horsepower equals 34.5 pounds of steam produced per hour.

All further comparisons in this chapter are based on these three models. However, the methodology can be applied to any size boiler. It is necessary to know only the size of the unit in horsepower or pounds of steam per hour and to calculate the fuel consumption in million BTU.

DETERMINERS OF EMISSIONS

Each combination of furnace and fuel has a different emission rate. The rates for particulate and sulfur dioxide emitted by the various types of furnaces that could be found in the three model installations are shown in Exhibit VI-4. These rates are presented in pounds of emissions per standard unit of measure, for example, pounds per ton of coal or per million cubic feet of natural gas.

For the example calculations, different levels of sulfur, ash, and BTU content have been assumed and are presented in Exhibit VI-5. These levels are not intended to be averages, but they are typical of the fuel. For a specific cost effectiveness analysis, specifications of the fuel of interest should be obtained, since there are numerous combinations of sulfur, ash, and BTU content in coal and fuel oil available in various parts of the United States.

EMISSIONS BY THE MODELS

To determine the pounds of sulfur dioxide and particulates emitted by an installation, the fuel consumption per hour in standard units of measure is calculated. The fuel requirements in BTU for the three models are given in Exhibit VI-3; the BTU contents of the various fuels are given in Exhibit VI-5. The fuel usage is obtained by dividing the BTU content of the fuel into the BTU requirement of the unit. The results of these calculations for the various fuels are shown in Exhibit VI-6. Note that

EXHIBIT VI-4

EMISSION RATES FOR VARIOUS TYPES
OF FURNACES BURNING
COAL, FUEL OIL, AND NATURAL GAS

Fuel	Furnace Type	Power Plants		Industrial Furnaces		Commercial Furnaces	
		Sulfur Dioxide	Particulates	Sulfur Dioxide	Particulates	Sulfur Dioxide	Particulates
COAL[3]	Pulverized:						
	Dry bottom	38S[2]	17A[2]	38S[2]	17A[2]	38S[2]	17A[2]
	Wet bottom:						
	With reinjection	38S	24A	38S	24A	38S	24A
	Without reinjection	38S	13A	38S	13A	38S	13A
	Cyclone	38S	2A	38S	2A	38S	2A
	Spreader stoker:						
	With reinjection	38S	20A	38S	20A	38S	20A
	Without reinjection	38S	13A	38S	13A	38S	13A
	Other stokers	38S	5A	38S	5A	38S	5A
	Hand-fired					38S	20
FUEL OIL[4]							
	1000 h.p. or more	157S	8	157S	8		
	Less than 1000 h.p.					157S	12
NATURAL GAS[5]							
	More than 100 million BTU/hr.	0.4	15				
	10-100 million BTU/hr.			0.4	18		
	Less than 10 million BTU/hr.					0.4	19

1/ Curtis Graline and Raymond Smith, A Rapid Survey Technique for Estimating Community Air Pollution Emission (U.S. Department of Health, Education, and Welfare, Cincinnati, October 1966) pp. 36, 38.
2/ "S" represents the percent sulfur by weight and "A" represents the percent ash by weight found in the fuels. Therefore, rates of three percent sulfur coal burned in any type furnace would result in emissions of 38(3)=114 pounds of sulfur dioxide per ton of coal.
3/ Emission rates for coal are in pounds of emissions per ton.
4/ Emission rates for fuel oil are in pounds of emission per 1000 gallons.
5/ Emission rates for natural gas are in pounds of emission per million cubic feet.

EXHIBIT VI-5

AVERAGE SULFUR, ASH, AND HEAT CONTENTS
ASSUMED FOR COAL, FUEL OIL, AND NATURAL GAS

Fuel Type	Sulfur (Percent by Weight)	Ash (Percent by Weight)	BTU Content
Coal	3.2	9	24,000,000/ton
	1.9	8	26,000,000/ton
	0.85	7	28,000,000/ton
	0.7	6	29,000,000/ton
No. 6 Fuel Oil	2.5	trace	152,000/gal.
	2.0	trace	152,000/gal.
	1.5	trace	152,000/gal.
	1.0	trace	152,000/gal.
	0.5	trace	152,000/gal.
No. 5 Fuel Oil	2.0	trace	148,000/gal.
	1.5	trace	148,000/gal.
	1.0	trace	148,000/gal.
	0.5	trace	148,000/gal.
No. 4 Fuel Oil	1.0	trace	145,000/gal.
	0.5	trace	145,000/gal.
No. 2 Fuel Oil	0.25	trace	135,000/gal.
No. 1 Fuel Oil	0.1	trace	130,000/gal.
Natural Gas	trace	trace	1000/cubic feet

EXHIBIT VI-6

CONSUMPTION PER HOUR OF
COAL, FUEL OIL, AND NATURAL GAS FOR
POWER PLANT, INDUSTRIAL, AND COMMERCIAL SIZE FURNACES[1/]

	Power Plant	Industrial Furnaces	Commercial Furnaces
Tons of coal consumed per hour[2/]			
3.2% sulfur content	8.3 tons	3.1 tons	0.4 tons
1.9% sulfur content	7.7	2.9	0.3
0.85% sulfur content	7.1	2.7	0.3
0.7% sulfur content	6.9	2.6	0.3
Gallons of fuel oil[3/] consumed per hour			
No. 6	1315.75 gal.	493.5 gal.	59.25 gal.
No. 5	1351.5	506.75	60.75
No. 4	1379.5	517.25	62.0
No. 2	1481.5	555.5	66.75
No. 1	1538.5	577.0	69.25
Cubic feet of natural gas[3/] consumed per hour	200,000 CF	75,000 CF	9,000 CF

1/ These figures represent the BTU requirement of the unit divided by the BTU content of the fuel (see Exhibits VI-3 and VI-5).

2/ The combustion efficiency of coal is assumed to be 85 percent.

3/ The combustion efficiency of fuel oil and natural gas is assumed to be 100 percent.

coal consumption is based on eighty-five percent combustion efficiency due to the loss of coal in handling and through the grates of the furnace during combustion. The other fuels are calculated at 100 percent efficiency.

Exhibit VI-7 presents the pounds of sulfur dioxide and particulate emitted per hour by the three models using the various types of fuels. The emissions were calculated with the emission rate for a specific furnace (Exhibit VI-4) and the amount of fuel consumed per hour (Exhibit VI-6).

EXAMPLES OF FUEL SUBSTITUTION AND SWITCHING

The purpose of the methodology presented in this chapter is to determine the cost of changing fuels in a particular installation to reduce sulfur dioxide and particulate emissions. In the examples that follow the detailed calculations are shown for a number of postulated alternatives. Exhibit VI-8 describes, step-by-step, the inputs and calculations of the example analyses.

Exhibit VI-9 shows the calculations to determine the cost and emission reduction effectiveness of substituting low sulfur coal for a high sulfur coal in an industrial boiler in Chicago, Illinois. Exhibit VI-10 analyzes the cost of a fuel switch from coal to oil and from coal to gas on an interruptible basis for the same boiler model in the same location.

A summary of the results of these two examples appears in Exhibit VI-11. This exhibit shows that if emissions must be reduced in the case chosen the best alternative presented is a switch to natural gas on

EXHIBIT VI-7

ESTIMATED POUNDS OF SULFUR DIOXIDE AND PARTICULATE EMITTED PER HOUR BY VARIOUS TYPES AND SIZES OF FURNACES USING COAL, FUEL OIL, AND NATURAL GAS[1]

	Fuel Type/Furnance Type	POWER PLANTS		INDUS. FURNACES		COMM. FURNACES	
		Sulfur Dioxide	Particulate	Sulfur Dioxide	Particulate	Sulfur Dioxide	Particulate
		Emissions in Pounds/Hour					
	Coal: Pulverized:						
1	Dry Bottom-3.2% sulfur	1009.3	1270.0	377.0	474.3	48.6	61.2
2	1.9%	555.9	1047.2	209.4	394.4	21.7	40.8
3	0.85%	229.3	844.9	87.2	321.3	10.0	35.7
4	0.7%	183.5	703.8	69.2	265.2	8.0	30.6
	Wet Bottom-						
5	With Reinjection-3.2%	1009.3	1792.8	377.0	669.6	48.6	86.4
6	1.9%	555.9	1478.4	209.4	556.8	21.7	57.6
7	0.85%	229.3	1192.8	87.2	453.6	10.0	50.4
8	0.7%	183.5	993.6	69.2	374.4	8.0	43.2
9	Without Reinjection-3.2%	1009.3	971.1	377.0	362.7	48.6	46.8
10	1.9%	555.9	800.8	209.4	301.6	21.7	31.2
11	0.85%	229.3	646.1	87.2	245.7	10.0	27.3
12	0.7%	183.5	538.2	69.2	202.8	8.0	23.4
13	Cyclone-3.2% sulfur	1009.3	149.4	377.0	55.8	48.6	7.2
14	1.9%	555.9	123.2	209.4	46.4	21.7	4.8
15	0.85%	229.3	99.4	87.2	37.8	10.0	4.2
16	0.7%	183.5	82.8	69.2	31.2	8.0	3.6
	Spreader Stoker:						
17	With Reinjection-3.2%	1009.3	1494.0	377.0	558.0	48.6	72.0
18	1.9%	555.9	1232.0	209.4	464.4	21.7	48.0
19	0.85%	229.3	994.0	87.2	378.0	10.0	42.0
20	0.7%	183.5		69.2	312.0	8.0	36.0
	Without Reinjection (same as wet bottom with reinjection)						
21	All Other Stokers-3.2%	1009.3	373.5	377.0	139.5	48.6	18.0
22	1.9%	555.9	308.0	209.4	116.0	21.7	12.0
23	0.85%	229.3	248.5	87.2	94.5	10.0	10.5
24	0.7%	183.5	207.0	69.2	78.0	8.0	9.0
25	Hand-fired Equipment-3.2%	-	-	-	-	48.6	8.0
26	1.9%	-	-	-	-	21.7	6.0
27	0.85%	-	-	-	-	10.0	6.0
28	0.7%	-	-	-	-	8.0	6.0
	Fuel Oil:						
29	No. 6-2.5% sulfur	516.4	10.5	193.7	3.9	23.3	0.7
30	2.0%	413.1	10.5	155.0	3.9	18.6	0.7
31	1.5%	309.9	10.5	116.2	3.9	14.0	0.7
32	1.0%	206.6	10.5	77.5	3.9	9.3	0.7
33	0.5%	103.3	10.5	38.7	3.9	4.7	0.7
34	No. 5-2.0% sulfur	424.4	10.8	159.1	4.0	19.1	0.7
35	1.5%	318.3	10.8	119.3	4.0	14.3	0.7
36	1.0%	212.2	10.8	79.6	4.0	9.5	0.7
37	0.5%	106.1	10.8	39.7	4.0	4.8	0.7
38	No. 4-1.0% sulfur	216.6	11.0	81.2	4.1	9.7	0.7
39	0.5%	108.3	11.0	40.6	4.1	4.9	0.7
40	No. 2-0.25% sulfur	58.1	11.9	21.8	4.4	2.6	0.8
41	No. 1 or Kerosene-0.10% sulfur	24.2	12.3	9.1	4.6	1.1	0.8
	Natural Gas:						
42	Firm Service	0.1	3.0	Trace	1.4	Trace	Trace

1/The emissions were calculated using the emission rate for a specific furnace (Exhibit VI-4) and the amount of fuel consumed per hour (Exhibit VI-6).

an interruptible basis. The additional annual cost of natural gas interruptible per pound of pollutant reduced is significantly less than any other alternative postulated, and at the same time the maximum reduction possible is twenty-five to almost 300 percent greater than the other alternatives.

The last example, Exhibit VI-12, compares the substitution of either low sulfur no. 6 fuel oil or low sulfur no. 5 fuel oil for high sulfur no. 6 fuel oil. The reduction in sulfur dioxide is approximately equal: sixty percent for low sulfur no. 6 and fifty-nine percent for low sulfur no. 5. But the cost per pound of sulfur dioxide reduced is greatly different: 2.6¢ per pound of sulfur dioxide reduced by substituting low sulfur no. 6 fuel oil and 9.2¢ per pound of sulfur dioxide reduced by substituting low sulfur no. 5 fuel oil. Therefore, substitution by no. 6 fuel oil with a one percent sulfur guarantee seems the better choice. However, if fuel switching is allowed, no. 6 fuel oil may not be the best alternative available, because Exhibit VI-10 shows that natural gas on an interruptible basis is less expensive than high sulfur no. 6 fuel oil, which is in turn less expensive than low sulfur no. 6 fuel oil.

EXHIBIT VI-8

INPUTS AND CALCULATIONS REQUIRED TO
DETERMINE THE COST AND
EFFECTIVENESS OF FUEL
SUBSTITUTION OR SWITCHING

INPUTS - COSTS

Cost per million BTU of present fuel
Cost per million BTU of alternative fuel
Fuel consumption per hour in million BTU
Annual hours of operation[1/]
Annualized boiler conversion costs[2/]

INPUTS - EMISSIONS

Emissions per hour using present fuel
Emissions per hour using alternative fuel
Annual hours of operation[1/]

CALCULATIONS

		Cost per million BTU of alternative fuel
(Step 1)	-	Cost per million BTU of present fuel
		Unit cost differential per million BTU
(Step 2)	x	Fuel consumption per hour in million BTU
		Additional fuel cost per hour
(Step 3)	x	Annual hours of operation[1/]
		Additional annual fuel cost
(Step 4)[2/]	+	Annualized boiler conversion costs
		Additional annual cost
		Emissions per hour using present fuel
(Step 5)	-	Emissions per hour using alternative fuel
		Emissions reduced per hour
(Step 6)	x	Annual hours of operation[1/]
		Annual Emissions Reduced
		Additional annual fuel cost
		or
		Additional annual cost[2/]
(Step 7)	÷	Annual emissions reduced
		COST PER POUND OF EMISSIONS REDUCED

1/ Hours per year X percent utilization.
2/ Fuel switching only.

EXHIBIT VI-9

COST EFFECTIVENESS OF FUEL SUBSTITUTION OF HIGH AND LOW SULFUR COAL IN AN INDUSTRIAL BOILER[1/]

Boiler Description

Boiler horsepower	1700
Fuel consumption	75,000,000 BTU per hour at maximum utilization
Furnace type	Pulverized wet bottom without reinjection

Present Fuel

High sulfur coal
- 3.2% sulfur by weight (Exhibit VI-5)
- 377.0 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 9% ash content by weight (Exhibit VI-5)
- 362.7 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 32¢ per million BTU (Exhibit I-4)

Substitution Fuel

Low sulfur coal
- 0.85% sulfur by weight (Exhibit VI-5)
- 87.2 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 7% ash content by weight (Exhibit VI-5)
- 245.7 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 40¢ per million BTU (Exhibit I-4)

Cost Differential

Low sulfur coal cost per million BTU	$0.40
(Step 1) High sulfur coal cost per million BTU	-0.32
Unit cost differential per million BTU	0.08
(Step 2) Fuel consumption per hour (million BTU)	X 75
Additional fuel cost per hour	$6.00

Exhibit VI-9 (Cont'd)

Cost Effectiveness of Fuel Substitution of High and Low Sulfur Coal in an Industrial Boiler[1/]

	Sulfur Dioxide	Particulate
Additional fuel cost per hour	$ 6.00	
(Step 3) Annual hours of operation (365 days a year, 24 hours a day, 60% utilization)	X 5,265	
Additional annual fuel cost	$31,590.00	
(Step 4) Not applicable to fuel substitution		
Emissions per hour using present fuel	377.0 pounds	362.7 pounds
(Step 5) Emissions per hour using alternative fuel	87.2	245.7
Pounds of emissions reduced per hour	289.8 pounds	117.0 pounds
(Step 6) Annual hours of operation	X 5,265 hours	X 5,265 hours
Annual emissions reduced	1,525,797.0 pounds	616,005.0 pounds
Cost per Pound of Emissions Reuction		
Additional annual fuel cost (from Step 3)	$31,590.00	$31,590.00
(Step 7) Annual emissions reduced (from Step 6)	÷1,525,797.0	÷616,005.0
Cost per pound of emissions reuced	$ 0.021	$ 0.051

1/ Calculations are numbered bysteps shown in Exhibit VI-8.

EXHIBIT VI-10

COST EFFECTIVENESS OF FUEL SWITCHING OF COAL WITH FUEL OIL IN AN INDUSTRIAL BOILER[1/]

Boiler Description

Boiler horsepower	1700
Fuel consumption	75,000,000 BTU per hour at maximum utilization
Furnace type (present)	Pulverized wet bottom without reinjection

Present Fuel

Coal
- 3.2% sulfur by weight (Exhibit VI-5)
- 371.0 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7
- 9% ash content by weight (Exhibit VI-5)
- 362.7 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 32¢ per million BTU (Exhibit I-4)

Switching Fuels

No. 6 fuel oil
- 2.5% sulfur by weight (Exhibit VI-5)
- 193.7 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 3.9 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 49¢ per million BTU (Exhibit I-4)
- $4,000 annualized boiler conversion costs (Exhibit VI-2)

Natural gas using interruptible service

Natural gas
- A trace of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 1.4 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 28¢ per million BTU (Exhibit I-4)
- $4,000 annualized boiler conversion costs (Exhibit VI-2)

No. 2 fuel oil
- 0.25% sulfur by weight (Exhibit VI-5)
- 21.8 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 4.4 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 72¢ per million BTU (Exhibit I-4)

Exhibit VI-10 (Cont'd)

Cost Effectiveness of Fuel Switching of Coal with Fuel Oil in an Industrial Boiler[1/]

I. Switching to low sulfur no. 6 fuel oil

Cost Differential				
Low sulfur no. 6 fuel oil cost per million BTU	$ 0.49			
(Step 1) High sulfur coal cost per million BTU	-0.32			
Unit cost differential per million BTU	0.17			
(Step 2) Fuel consumption per hour (million BTU)	X 75			
Additional fuel cost per hour	$ 12.75			
(Step 3) Annual hours of operation (365 days a year, 24 hours a day, 60% utilization)	X 5,265			
Additional annual fuel cost	$67,128.75			
(Step 4) Annualized boiler conversion costs	+4,000.00			
Additional annual cost	$71,128.75			
Emissions Reduced	**Sulfur Dioxide**		**Particulate**	
Emissions per hour using present fuel	377.0	pounds	362.7	pounds
(Step 5) Emissions per hour using low sulfur no. 6 fuel oil	-193.7	pounds	3.9	pounds
Pounds of emissions reduced per hour	183.3		358.8	
(Step 6) Annual hours of operation	X 5,265		X 5,265	
Annual emissions reduced	965,074.5	pounds	1,889,082.0	pounds
Cost per Pound of Emissions Reduced				
Additional annual cost (from Step 4)	$71,128.75		$71,128.75	
(Step 7) Annual emissions reduced (from Step 6)	÷965,074.5		÷1,889,082.0	
Cost per pound of emissions reduced	$ 0.074		$ 0.038	

Exhibit VI-10 (Cont'd)

Cost Effectiveness of Fuel Switching of Coal with Fuel Oil in an Industrial Boiler[17]

II. Switching to natural gas using interruptible service

Assumption: Natural gas is used alone to generate 90 percent of the heat consumed annually. The remaining 10 percent is generated by no. 2 fuel oil.

Cost Differential		
Natural gas cost per million BTU	$ 0.28	$ 0.72
No. 2 fuel oil cost per million BTU (Step 1) High sulfur coal cost per million BTU	-0.32	-0.32
Unit cost differential per million BTU		
natural gas	-0.04	
no. 2 fuel oil		0.40
(Step 2) Fuel consumption per hour (million BTU)	X 75	X 75
Additional (decreased) fuel cost per hour	($ 3.00)	$ 30.00
(Step 3) Annual hours of operation (365 days a year, 24 hours a day, 60% utilization)	X 5,265	X 5,265
Additional (decreased) annual fuel cost (100% usage)	($15,795.00)	$157,950.00
Percent of annual fuel consumption		
natural gas	0.90	
no. 2 fuel oil		0.10
Additional (decreased) annual cost		
natural gas	($14,215.50)	
no. 2 fuel oil		15,795.00
Additional annual fuel cost		1,579.50
(Step 4) Annualized boiler conversion costs		+4,000.00
Additional annual cost		$ 5,579.50

Exhibit VI-10 (Cont'd)

Cost Effectiveness of Fuel Switching of Coal with Fuel Oil in an Industrial Boiler[1/]

	Sulfur Dioxide		Particulate	
Emissions Reduced - natural gas				
Emissions per hour using present fuel	377.0	pounds	362.7	pounds
(Step 5) Emissions per hour using natural gas	-Trace		1.4	pounds
Pounds of emissions reduced per hour	377.0		361.3	
(Step 6) Annual hours of operation	X 5,265		X 5,265	
Annual emissions reduced (100% usage)	1,984,905		1,902,244.5	
Percent of natural gas consumption	0.90		0.90	
Annual emissions reduced	1,786,415	pounds	1,712,020	pounds
Emissions Reduced - no. 2 fuel oil				
Emissions per hour using present fuel	377.0	pounds	362.7	pounds
(Step 5) Emissions per hour using natural gas	-21.8	pounds	-4.4	pounds
Pounds of emissions reduced per hour	355.2		358.3	
(Step 6) Annual hours of operation	X 5,265		X 5,265	
Annual emissions reduced (100% usage)	1,870,128		1,886,450	
Percent of no. 2 fuel oil consumption	0.10		0.10	
Annual emissions reduced	187,013	pounds	188,645	pounds
Cost per Pound of Emissions				
Additional annual cost (from Step 4)	$5,579.50		$5,579.50	
(Step 7) Annual emissions reduced (from Steps 6)	÷1,973,428		÷1,900,665	
	$ 0.00283		$0.00293	

1/ Calculations are numbered by steps shown in Exhibit VI-8.

EXHIBIT VI-11

SUMMARY OF COST AND EFFECTIVESS OF ALTERNATIVE FUEL CHANGE EXAMPLES,
EXHIBITS VI-9 AND VI-10

	Sulfur Dioxide				Particulate		
	Additional Annual Cost	Annual Reduction of Emissions		Cost per Pound of Emissions Reduced	Annual Reduction of Emissions		Cost per Pound of Emissions Reduced
		Pounds	%		Pounds	%	
High Sulfur Coal	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Low Sulfur Coal	$31,590.00	1,525,797.0	76.9	2.1¢	616,005.0	32.3	5.1¢
No. 6 High Sulfur Fuel Oil	71,128.75	965,074.5	48.6	7.4¢	1,889,082.0	98.9	3.8¢
Natural Gas using Interruptible Service	5,579.50	1,973,285.1	99.4	0.28¢	1,900,665.0	99.5	0.29¢

EXHIBIT VI-12

COST EFFECTIVENESS OF FUEL SUBSTITUTION OF HIGH AND LOW SULFUR HEAVY FUEL OIL IN AN INDUSTRIAL BOILER[1/]

Boiler Description	
Boiler horsepower	1700
Fuel consumption	75,000,000 BTU per hour at maximum utilization
Furnace type	Heavy fuel oil

Present Fuel

No. 6 fuel oil with no sulfur maximum

- 2.5% sulfur by weight
- 193.7 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 3.9 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 49¢ per million BTU (Exhibit I-4)

Substitution Fuel

No. 6 low sulfur fuel oil

- 1% sulfur by weight
- 77.5 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 3.9 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 53¢ per million BTU (Exhibit I-4)

No. 5 low sulfur fuel oil

- 1% sulfur by weight
- 79.6 pounds of sulfur dioxide emitted per hour at maximum utilization (Exhibit VI-7)
- 4.0 pounds of particulate emitted per hour at maximum utilization (Exhibit VI-7)
- 63¢ per million BTU (Exhibit I-4)

Exhibit VI-12 (Cont'd)

Cost Effectiveness of Fuel Substitution of High and Low Sulfur Heavy Fuel Oil in an Industrial Boiler[1/]

	Substitution of No. 6	Substitution of No. 5
Cost Differential		
Low sulfur fuel oil cost per million BTU	53¢	63¢
(Step 1) High sulfur no. 6 cost per million BTU	-49¢	-49¢
Unit cost differential per million BTU	4¢	14¢
(Step 2) Fuel consumption per hour (million BTU)	X 75	X 75
Additional fuel cost per hour	$3.00	$10.50
(Step 3) Annual hours of operation (365 days a year, 24 hours a day, 50% utilization)	X 5,265 hours	X 5,265 hours
Additional annual fuel cost	$15,795.00	$55,282.50
(Step 4) Not applicable to fuel substitution		
	Sulfur Dioxide	
Emissions Reduced		
Emissions per hour using present fuel[2/]	193.7 pounds	193.7 pounds
(Step 5) Emission per hour using alternative fuel	-77.5 pounds	-79.6 pounds
Pounds of emissions reduced per hour	116.2 pounds	114.1 pounds
(Step 6) Annual hours of operations	X 5,265 hours	X 5,265 hours
Annual emissions reduced	611,793.0 pounds	630,773.3 pounds
Cost per Pound of Emissions		
Additional annual fuel cost (from Step 3)	$15,795.00	$55,282.50
(Step 7) Annual emissions reduced (from Step 6)	÷611,793.0 pounds	÷630,773.3 pounds
Cost per pound of emissions reduced	$0.026	$0.092

1/ Calculations are numbered by steps shown in Exhibit VI-8.

2/ The particulate emission is excluded because it is constant.

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